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A Message From the Administrator

Increasingly, all of us are becoming involved in the process of interpreting the law. The Congress has seen fit to assign to NOAA an ever-broadening range of responsibilities for the implementation of laws in which there are great interests at stake and the interpretation of which by our organization can have vast impact upon what we as a Nation do about maintaining the quality of our environment, the viability of our economy or simply the well-being of our citizens.

Each time we write a set of regulations which seek to specify how the provisions of a given law will be interpreted or carried out, we are discharging one of the most sensitive and difficult tasks of the Federal Government. During this process, the groups and parties which will be affected by those interpretations have a variety of ways to give us their views. It is important that we be diligent in providing the opportunities required by law for all parties to present their views, as well as other forms of access for any groups which may have views they wish to express, so that at all times we are fully sensitive to the impact of our decisions on affected persons.

The task is not an easy one, and many times it is thankless. Many of the situations in which we find ourselves result in decisions or conclusions which are displeasing or disadvantageous to one party or another. While we can be sympathetic with both the displeased and the disadvantaged, our task is always to carry out the provisions of the law as we best see them, objectively, on the basis of the finest scientific and technical evidence we can provide, and of a full and free exchange of views and information concerning impacts of proposed measures.

We must recognize that it is not possible to make all people happy. Laws were not intended to do that. Laws were intended to carry out the policies established by the Congress and it is important that our personal views, emotions and feelings be kept as separate as is humanly possible from our need to carry out the law.

There will be instances in which our interpretation of the laws are called into question. There may occasionally be tests in the courts of such interpretations. We should welcome clarification by the courts of the laws passed by Congress. That's what the courts are for. In some cases Congress has deliberately left broad areas of discretion for the administering agency. In other cases the laws, being written by humans, are not as clear as they might be.

As yet, most of our activities which require the difficult decisions of interpretation fall within the coast and ocean area. Formidable tasks are ahead of us in the further implementation of the Coastal Zone Management Act, the Marine Mammals Protection Act, the Endangered Species Act, the Marine Protection, Research and Sanctuaries Act and the many fisheries acts which implement international agreements pursuant to treaties. The Congress is now considering additional legislation which will place further responsibility on our organization.

Over the years, we have been building the kinds of capabilities in our organization that we need to discharge these kinds of responsibilities properly. To do this job well requires the diligence and talents of our legal staff, our scientists, our economists, and all those who have become deeply involved in the social and political implications of Governmental policy. Working together, I know that we can do this most difficult task in a fair, firm and yet sympathetic manner.

Robert M White

A new NOAA service helps America to

Share The Heat

BY EDWIN P. WEIGEL

As a result of industry predictions of shortages of natural gas in large portions of the United States this winter, numerous agencies, public and private, have teamed up to make the best possible allocation of this vital natural resource.

The basic goal is to share the gas in such a way that there is a minimum of hardship.

A new contribution by NOAA, begun recently, is a weekly weather-information service to 48 state capitals to help state officials determine just where they stand that particular week in terms of heating-fuel usage and to predict what the next five days will bring in terms of heating-fuel needs. (Alaska and Hawaii are not included because they do not use significant amounts of natural gas.)

Two major components of NOAA have teamed up to provide the new information service—the Environmental Data Service and the National Weather Service.

The Environmental Data Service has supplied each state with a base graph showing the normal curve of accumulated cold weather in the state throughout the heating season, plus curves on either side showing the extremes of cold or warm weather that have occurred an average of once every ten seasons in that state. NOAA's National Weather Service is providing each state with weekly data on observed amounts of cold weather thus far and a prediction of what's to come.

To appreciate the significance of this new service, an understanding of the importance of the natural-gas industry is necessary, along with background about its current problems.

According to the American Gas Association, the United States is using up its proven reserves of natural gas more rapidly than new reserves are being discovered. The Association says it is confident that, with proper incentives, enormous new deposits of natural gas can be discovered on U.S. outer continental shelves of the Atlantic and Pacific, in Alaska, the Gulf of Mexico and within the lower 48 states.

But meantime, says the Association, the order of the day should be conservation. Why? Because natural gas is the nation's dominant source of energy.

With the coldest months still ahead, fuel experts remind us not to readjust thermostat frequently (above). Unsightly scar on the earth (opposite page) will disappear when this soon-to-be buried pipeline is covered and, unseen, will carry natural gas to many users.

Before World War II, most natural gas was "flared" (burned) as a useless by-product. Now, 35 million households, half the nation's total of 70 million, are heated by natural gas. An additional six million use natural gas for other purposes, such as water heating.

Natural gas furnishes the United States with almost a third of its total energy requirements for residential, commercial and industrial uses. When fuel used for transportation is excluded, natural gas provides 41 per cent of all domestic energy production.

According to the U.S. Council on Environmental Quality, natural gas is more than twice as efficient as electricity for home-heating, because most electricity is made by burning coal, oil and natural gas, with resulting energy loss, whereas gas itself can be used directly in its natural form. It is the nation's most economical fuel, more so than oil, coal, coke, wood or any other flammable substance you can name.

Also, natural gas is our cleanest source of fossil-fuel energy, says the Council on Environmental Quality, because it is virtually free of the atmospheric pollutants produced by the burning of coal or oil.

The industry that makes available this vital resource consists of three major components. First are the producers that extract the gas from underneath the ground, such as Exxon, Mobil, Gulf, Texaco and thousands of independents. Second are the major pipeline companies that distribute the gas to the 48 states through a million-mile network. And third are the local utilities to which monthly bills are paid for home heating.

The producing and pipeline segments of the industry are regulated by the Federal Power Commission, which determines prices for interstate gas at the wellhead. These segments are also overviewed by the Federal Energy Administration and other agencies to keep track of their state of health. The distributors come under the surveillance of the state public utility commissions.

As of now, the consensus of the overseers is that an intensive search for new reserves is needed, plus at least a temporary belt-tightening in many states. The states predicted to feel the pinch most severely this winter were listed in October by the Federal Energy Administration as Arizona, California, Delaware, Florida, Georgia, Indiana, Iowa, Kansas, Kentucky, Maryland/D.C., Missouri, Nevada, New Jersey, New York, North Carolina, Ohio, Pennsylvania, South Carolina, Tennessee, Virginia, and West Virginia.

In those states, NOAA's new service should be a vital factor in helping energy advisers make judicious allocations of heating fuel. To do so, however, they have had to become familiar with a concept called the "heating degree day," developed many years ago by heating engineers to provide a useful measure of the way cold weather of a given severity and duration affects consumption of heating fuel, in the absence of actual measurements of fuel use.

The heating degree day is pegged to a temperature of 65 degrees F., agreed upon as the dividing line between where some amount of furnace heat ordinarily is re-

quired to provide a comfortable indoor temperature, and where it is not. When the average temperature for a given day (which is obtained by adding together the low and high and dividing by two) is one degree below 65, that counts as one degree day. If the average is two degrees below 65, it is two degree days, and so on down the thermometer scale. Successive daily totals of degree days are added together to produce the cumulative totals of degree days for a week, or a month or a season.

The degree-day concept assumes that the same amount of heating fuel is needed for any combination of cold and duration that add to the same number of heating degree days. For example, 10 days at 64 degrees, five days at 63 degrees, two days at 60 degrees, and one day at 55 degrees all equal 10 heating degree days. Presumably each combination would call for the same amount of heating fuel. Over the years, the analogy has been found close enough to be useful for estimating customers' heating fuel needs during spells of cold weather.

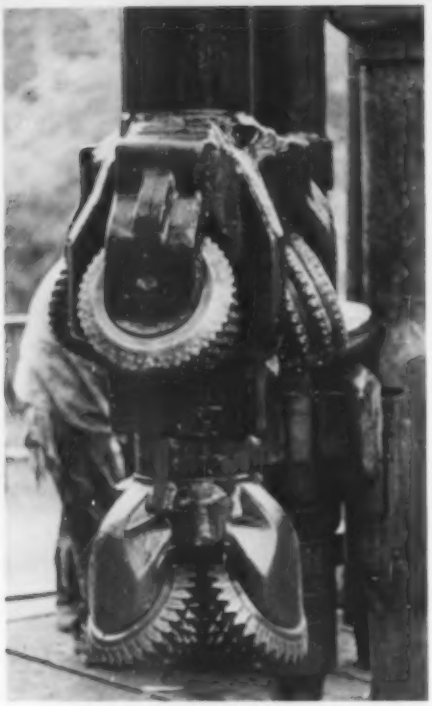
Both the Environmental Data Service graphs, showing normal and extreme accumulations of heating degree days during the season, and the Weather Service observations and forecasts are population weighted, so that cold weather reports from a large city, where heating needs are great, weigh more heavily than equally cold weather in a sparsely populated region of the state.

The base graphs against which current and projected degree days are plotted were provided by the Environmental Data Service's Center for Climatic and Environmental Assessment (CCEA), under the direction of Dr. James D. McQuigg. With these graphs it is a simple matter for state energy advisers to apply current and projected National Weather Service data to find out where their states stand in regard to heating-fuel usage and needs.

Weekly statewide degree-day statistics are provided by the National Weather Service's Long Range Prediction Group, under the direction of Dr. Donald L. Gilman. Each Wednesday morning, the National Meteorological Center distributes by teletype "population-weighted state degree-day summaries and forecasts." These tabulate nine values for each state. The first three values are the state's degree-day total for the week ending the previous Sunday, the normal total for that week of the year, and last year's total for that week. The second three values are the cumulative total of degree days since July 1, 1975, the 30-year norm for the corresponding period, and last year's total for that period. The last three values are the prediction of total degree days for the week to end the coming Sunday, the normal for that week of the year, and last year's total for that week. (The first two days are observed data, the remaining five are predictions.)

The forecast portion of this service is being provided for the first time this year in response to needs generated by the predicted natural-gas shortage.

In addition to the above-described fuel-



Drilling rigs with heavily-toothed bits drill deeper than ever before to find natural gas to satisfy the nation's increasing demand. Graph below is stylized version of type going to 48 states to help them determine heating-fuel needs. At right is sample of weekly teletype summary and forecast.

planning graphs for 48 states, Dr. McQuigg and his colleagues have prepared for two of those states—Missouri and North Carolina—mathematical models by which population-weighted degree days can be linked specifically to demand for natural gas. These models are based on a "marriage" of degree-day statistics with actual records of natural-gas usage provided by industry.

By this means it is expected that the severity of a potential natural-gas shortage can be quantified much more precisely for those states, making possible better decisions for allocation. Under current plans residential users of natural gas will be the last to be affected, although home users of natural gas may be asked to cut back somewhat on their use so that nonresidential users such as factories and commercial buildings will not be cut off completely.

Once Missouri and North Carolina pilot models have become operational, it is expected that other states will want to develop the same capability for translating degree-day data into quantified natural-gas demand. Dr. McQuigg and his colleagues will be prepared to tell each state energy team how to gather the necessary historical information and how to construct a mathematical model tailored to their natural-gas consumption and distribution system.

Each state's model will be different. Once produced, however, it will be a simple matter each week for the state to assess its position.

The economic impact of the anticipated shortages in each state will vary depending on the severity of the winter and on conservation measures either ordered by state officials or entered into voluntarily by businesses, industries and householders. The Federal Energy Administration says private residences will be little affected, and that, "while the commercial sector will be affected in some states, the major impact will be amongst industrial users of natural gas," some of whom "will be forced to shut down or reduce production."

FEA adds, however, that "conservation can play an important role this winter in ameliorating the impacts of industrial curtailments," and that, "although each residential and commercial customer consumes a relatively small amount of natural gas, concerted conservation efforts by homeowners and businessmen can add up to a sizeable savings.

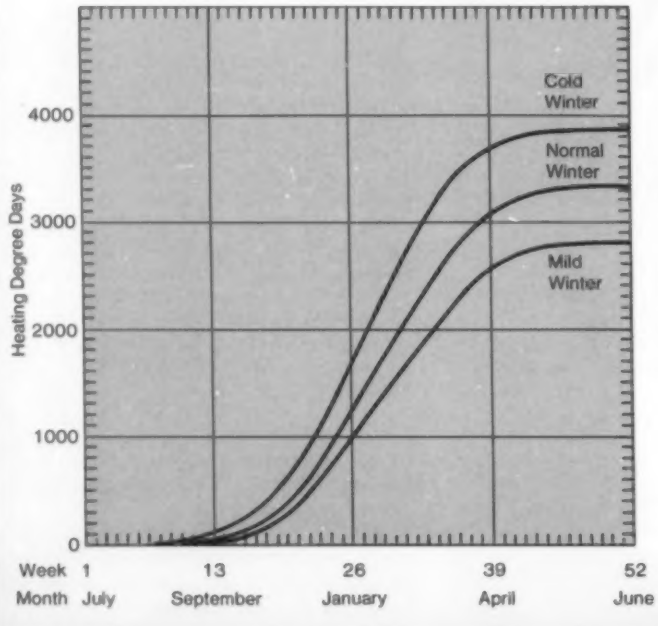
"For instance, reducing one's thermostat from 72 to 68 degrees saves 20 per cent of heating use, and lowering the thermostat to 60 degrees at night an additional 10 per cent. Lowering the temperature of a gas water heater from 140 to 110 degrees cuts consumption by 15 per cent without affecting hot-water availability. Six inches of blanket-type attic insulation can save 20 per cent. Caulking, weather stripping, storm doors and so on, can save another 10 per cent."

The result, says FEA, may be that such conservation can "release substantial amounts of natural gas for industrial use and thereby lessen the possibility of unemployment caused by industrial curtailments."

State of North Carolina

Weekly Normal Accumulated Heating Degree Days And 90% Confidence Interval

(Divisions Weighted by Population) July - June



Population-Weighted State Degree-Day Summary and Forecast

	Weekly Obsvd. Ends 11/23/75			Sum. From Jul. 1 Ends 11/23/75			Weekly Fcst. Ends 11/30/75		
	Curr.	Norm.	L. Yr.	Curr.	Norm.	L. Yr.	Curr.	Norm.	L. Yr.
Connecticut	127	167	188	666	900	1022	209	190	223
Delaware	116	146	161	556	697	786	180	168	205
Washington DC	89	132	127	318	562	557	165	152	165
Indiana	147	179	149	752	890	984	243	200	211
Kentucky	132	154	124	600	704	808	210	171	182
Maine	176	206	215	1320	1449	1486	255	230	252
Maryland	100	141	141	418	646	645	177	162	183
Massachusetts	103	151	159	567	817	964	197	174	203
New Hampshire	184	201	236	1368	1317	1555	262	227	272
New Jersey	99	140	150	491	662	732	176	161	193
New York	114	156	159	664	820	940	201	178	215
North Carolina	98	107	109	348	473	534	140	124	157
Ohio	140	177	146	824	938	1016	232	198	213
Pennsylvania	120	165	163	679	883	871	207	186	206
Rhode Island	128	163	176	772	918	1047	210	186	213
Vermont	190	207	220	1191	1357	1492	272	234	276
Virginia	96	125	131	371	551	607	157	143	166
West Virginia	130	157	157	684	813	928	208	176	193

Energy Conservation Guide*

Energy Use	Today	Tomorrow	
Air Conditioning	Set thermostat at 78° Close blinds on sunny side Close storm windows Turn thermostat up if house is vacant Open windows at night Don't add extra heat from lights, cooking, etc. Keep doors and windows closed Clean filters Clean supply and return registers Wear light clothing		
Heating	Set thermostat at 68° Open blinds on sunny side Close them at night Turn thermostat down 5-10° at night Close fireplace damper when not in use Clean air filter, radiators, supply registers Close off unused rooms Keep furniture away from radiators, registers Keep doors and windows closed Wear warm clothing	Insulate your home Install storm windows and doors Caulk around doors and windows Keep heating plant in good repair and maintenance Seal leaking ducts and insulate ducts in unheated areas	Install a humidifier New room additions should be well insulated with individual thermostats If you build a new home install a heat pump
Kitchen Cooking	Cover pots Use small amounts of water Turn setting down as soon as water starts to boil Cook entire meal in oven Cook double quantities and freeze half for later Match pan size to heating element size Use flat bottom pans Use countertop frypans, broilers, instead of range	Replace dented pots Buy covers for pots Replace worn oven door seals	Buy well insulated ovens Buy countertop appliances for dishes you prepare frequently Buy a microwave oven
Refrigerator-Freezers	Defrost frequently Avoid repeated door opening Set refrigerator at 40°, freezer at 0° Keep freezer full Keep outside coils clean	Replace worn door seals	Buy refrigerators or freezers that are properly sized and well-insulated
Dishwasher-Washer-Dryer	Do only full loads Don't overwash or overdry Turn off dishwasher in dry cycle and open door Clean lint traps frequently	Keep appliances in good repair Fix leaking faucets Set water heater temperature at 140° to 150°	Locate water heater near kitchen and washer/dryer.
	Change your habits so that you use your heavy appliances and hot water before 8 a.m. or after 10 p.m. during the summer		
Bathing-Shaving-Dishwashing	Don't leave water running Take showers instead of tub baths	Install water pressure limiting device on shower	
Lighting-TV-Small Appliances	Turn off unused lights and appliances	Keep appliances in good repair	Install fluorescent lighting where lights are on for long periods Shop for energy efficient appliances

*Energy conservation advice provided by the Virginia Electric Power Company

Clamshell Commerce: How Seafood Started the States

BY GERALD D. HILL, JR.

Fish were valued so highly by the American colonists that they may be considered the backbone of early American finance.

They were so important to survival of the colonies that fishermen were even exempt from military service. But stiff penalties were imposed on fishermen who did not report their catch to the proper authorities.

Fish were believed to be useful in many ways. They were fashioned into medicines to treat toothaches and bleeding wounds. One abundant species gave its name to Cape Cod in 1602. Fish were so much a part of business in colonial days that Mt. Vernon's necessities were primarily procured through the barter of herring; and Yale, third oldest educational institution in the United States, was financed from oysters.

Indeed, the Pilgrims are said to have told King James that fishing induced them to sail to America. Cod, herring, whale oil, and clamshells were a source of currency at colonial money exchanges—and an entire American frontier was financed with fish.

Seventeenth century England thought of its overseas colonies almost completely in terms of trade. Profits brought people, and only people who could sustain profits stayed in the New World. The establishment of the Virginia colony took time, and crops did not make an important agricultural contribution for the first 100 years. The only visible profits other than land awaiting the English entrepreneurs were furs and fish, found in the New England area. Of these two, with a constantly demanding market in Europe, fish were to prove the most valuable. So it came to be that business first focused on fish.

As early as 1557, some of the major countries of Europe sent several hundred ships to the New England area annually. These fishermen were drawn by the bountiful fishing grounds and spurred on by the lucrative trade which was to become America's first industry.

Mayflower

This lure of the fishing trade not only accounted for the actual settlement attempts in New England by the Pilgrims, but ultimately provided the commercial sustenance for the Massachusetts Bay Colony. Fish financed this first frontier by taking colonial business enterprises out of the red and into profit. The fishing industry's trade gave rise to the shipping and lumber industries, leading to a flourishing trade with the West Indies. This first commerce or foreign trade began an era of prosperity when the colonists realized that there were a number of marketable commodities they could provide. Thus, the fishing industry developed and played a vital part in the settling and survival of America.

The first to chronicle America's fisheries was Capt. John Smith, in his pamphlet, *Description of New England*, written after a voyage to the area in 1614. Sailing up the New England coast, one of the world's greatest fishing grounds, he found the cool, shallow waters of the Continental Shelf to be rich with cod, herring, mackerel, and many other species. Like explorers 12 years before, Smith was amazed at the waiting catch. He extolled the possibilities of fisheries contributing to the early economy and drew the attention of several adventurous English merchants interested in capitalizing on this highly desired product. Ultimately the Pilgrims saw a chance for relocating with a means of subsistence, and agreed to put in with a venture financed by Thomas Weston and other merchants. In a request to depart for the New World, they told the King that the profits expected would be from fishing. "T'is an honest trade!" was the reply and the Mayflower set sail.

Landing on a hostile shore, they spent too much time working unfertile soil and not enough at building profits with fisheries. Their foodstuffs had to be sent in from England and they lacked the skills to set up an economy which would balance their debts and so the mission failed. One of them wrote dolefully of the problem:

"Nov. 11, 1620. And every day we saw whales playing hard by us; of which in that place, if we had instruments and means to take them, we might have made a very rich return; which, to our great grief, we wanted. Our master and his mate, and others experienced in fishing, professed we might have made three or four thousand pounds' worth of oil. They preferred it before Greenland whale fishing, and purpose the next winter to fish for whale here. For cod we assayed but found none; there is good store, no doubt, in their season. Neither got we any fish all the time we lay

Illustration from work entitled De Bry Americae, *published in 1628, shows clamshell commerce in action — English trading with Indians of the West Indies.*

there, but some few little ones on the shore. We found great mussels, and very fat and full of sea pearl; but we could not eat them, for they made us all sick that did eat, as well sailors as passengers." (*Chronicles of the Pilgrim Fathers of the Colony of Plymouth,* Alexander Young)

However, at this time a thriving fishing industry already existed on the island of Monhegan (Maine), 20 miles off Penobscot Bay. Years of persistence had paid off in know-how which the Pilgrims had hoped, but failed, to obtain. With easy access to excellent fishing waters, this island was the center of the fishing activity ranging from Cape Ann to the Penobscot where fishing stations were becoming more permanent. New England's bays and inlets afforded excellent harbors for fishing craft, and the privately financed industry kept busy, responding to the European demand. In small boats averaging about 60 tons, they sailed with their catch into Spanish, French, and Mediterranean ports.

This lucrative trade with Europe did not pass unnoticed in an England irked with the Dutch monopoly of herring. Still mindful of Capt. Smith's appraisal of trade possibilities, London interests financed still another venture and the Puritans arrived.

Herein America's first industry, established early in the 1600's, makes its contribution to the success of American commercial interests. With its bountiful supply, the industry assured permanence to the Massachusetts Bay Colony. With the failure to create an economy based on home manufactures, and with the fur and mining businesses declining, fish were successfully used as a medium of exchange.

The existing trade plan with England was altered by enterprising colonial merchants to build profits. Originally, England supplied merchandise and equipment to the colonists who returned cargoes of fish to be re-sold in European ports. There were two major markets for the fish. The highest grades were sent to Portugal and Spain. The larger share of each catch was an inferior grade which was carried to the Atlantic islands off Europe, and to the West Indies where it was sold as a cheap protein food to feed slaves. This arrangement, however, left the New World businessmen with little profit from their very marketable natural commodity. Using their coastline resource, the colonists jointly financed their own forays into the market, returning with wine and fruits from Spain and the Canary Islands.

As the fisheries trade took hold, the need for craft gave rise to the shipping industry which produced vessels that were superior in quality and less expensive than the English vessels. Trade to the West Indies, exchanging the cheaper fish cargoes for molasses and rum, brought the realization that there was another product that could be

traded: timber. Making up for a lack of suitable cropland, colonists found the forests a worthy cause for effort. Not only did the trees serve as material for shipbuilding, but gave up other wooden products such as hoops and barrels. As trade increased, these items and other colony products found, like the fish, a thriving and rewarding market in the West Indies.

An extension of the colonial fishing business which contributed to the prospering trade with England was the whaling industry.

Early explorers had noticed the numbers of whales off Nantucket Island, and the first settlers carefully used the occasional carcasses which washed up on the beaches. The animal was cut up, bone extracted, and the remainder boiled to obtain the oil. The products were then shared equally among the townsfolk, and the fin and tail portions were used by the Indians.

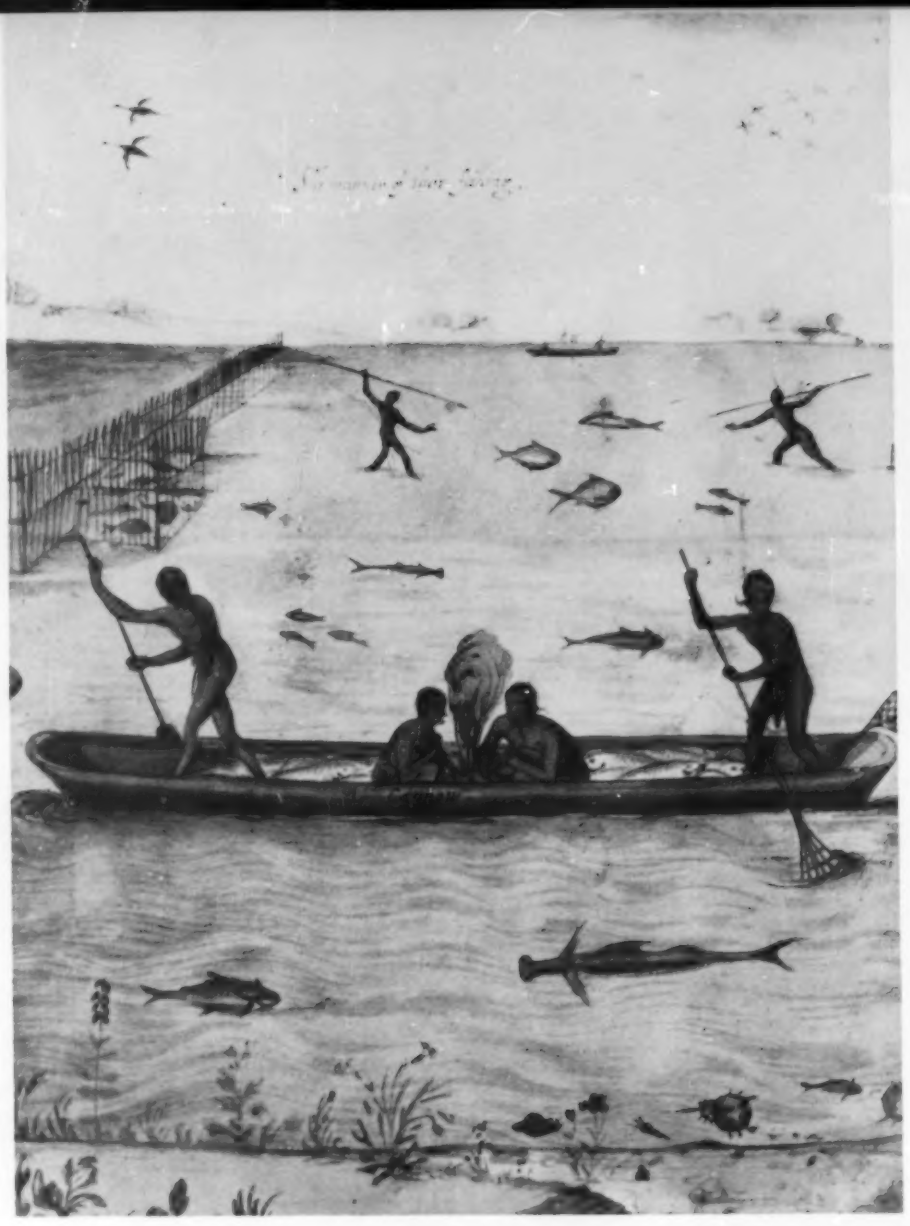
After a while, however, the pioneers decided not to depend on Providence, took matters into their own hands, and began putting out to sea in small boats after the living prey. Many whale were harpooned in sight of the island, but with the decline of the resource, larger vessels were eventually designed and sailed to more distant whaling grounds.

By the end of the colonial period, the American whaling industry was equal to that of Great Britain and France. Further diversifying the New England economy, whaling produced commodities marketable not only at home but in the West Indian trade. Baleen whales gave oil for fuel in lamps, for use in leather manufacture, and as a lubricant. The baleen or whalebone was used for corset stays and to stiffen clothing such as skirts and collars. Teeth from the sperm whale were a source of ivory for carvings.

Pursuing this profitable prey in ever widening circles, the seafarers found the excursions becoming long and dangerous. Once the whale was sighted and harpooned, it required all the ingenuity the ship's master could muster to outmaneuver his intended prey. Often the whale would turn and ram the ship or destroy it with a flip of his tail, and all would be lost. Many a captain must have hesitated before deciding to go on and risk it all; however, the prize was great. A single cargo could bring up to $100,000, but lesser amounts were more common. Often there were heavy losses.

Early merchants indulged in price-wage fixing in coping with their inflationary times. In 1761—with demand outrunning supply and bidding for the whaler's products high—a group of colonial candlemakers agreed on a fixed price for the raw materials in an effort to stabilize the business. The products were so valuable, however, that this gentlemen's agreement proved ineffective, with one or another outbidding his competitors.

Since each lengthy voyage could result in either disaster or great fortune, each departure and arrival of the whalers was a special event. Returning ships were met at the docks by a large crowd of friends and relatives, and a successful trip made many



a fisherman the envy of his neighbors. When oil as a form of currency brought a good price at the local exchanges, many new hands could be found to sign up for the next adventurous catch.

In these early times fish were put to use in many ways—used for everything from glue to medicinal aids. Oyster shells were used for lime in building, and fish were a common source of fertilizer in New England. Indians showed early Virginia settlers the value of planting menhaden under corn stalks to increase the yield. From this came the first attempts at a commercial fertilizer. Oil from these fish was put to work in paints and in dressing leather.

New England Rarities, 1672, instructed the colonists on some of the uses for fish:

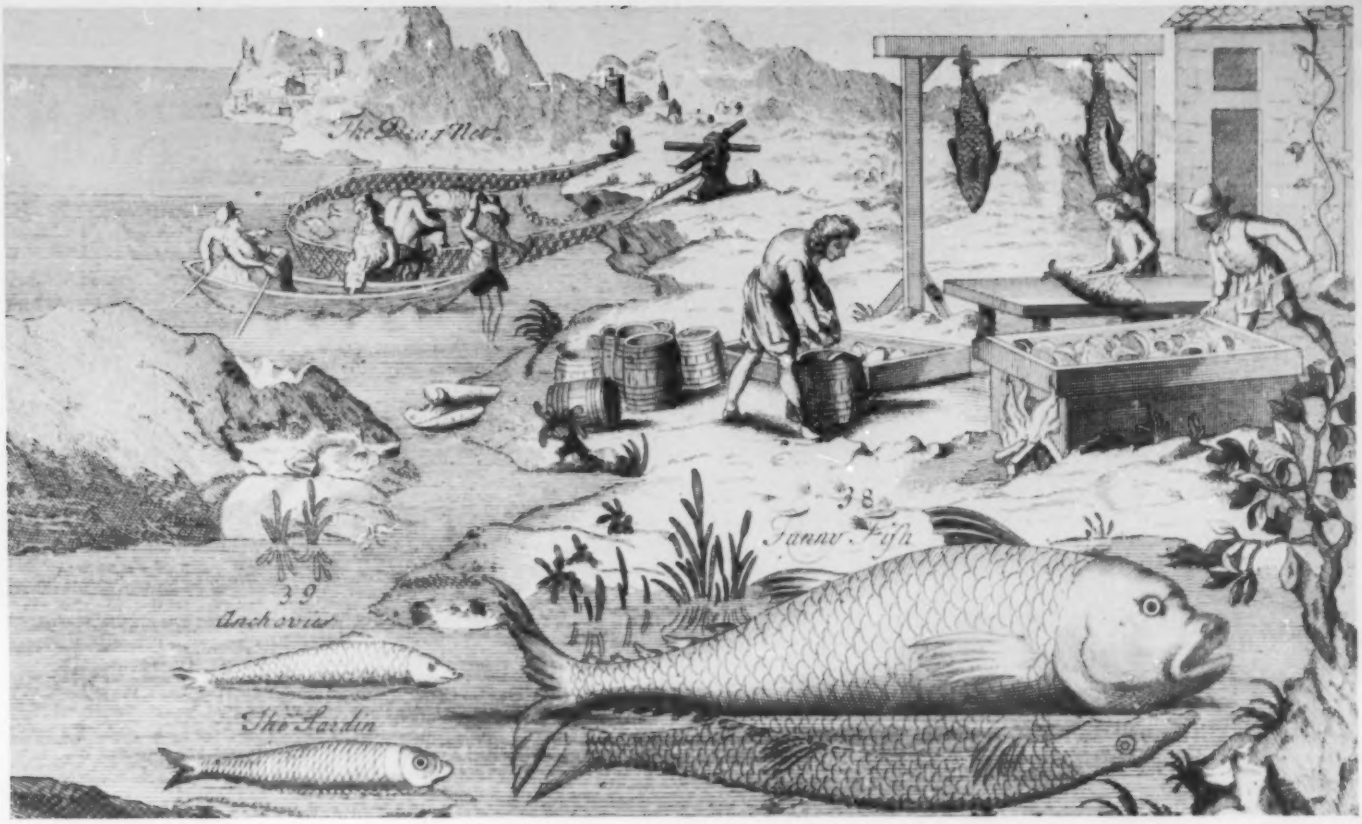
"The cod: is a staple commodity in the country. To stop fluxes of the blood,—in the head of this fish is found a stone, or rather a bone which, being pulverized and drank in any convenient liquor, will stop (bleeding) notably. For the stone,—there is a stone found in their bellies in a bladder against their naval which, being pulverized and drank in white wine posset or ale, is present remedy for the stone. To heal a green cut,—about their fins you may find a kind of louse which heals a green cut in short time.

"The dog fish: a ravenous fish. For the toothache,—upon whose back grows a thorn, two or three inches long, that helps the toothache, scarifying the gums therewith. Their skins are good to cover boxes and instrument cases.

"The sturgeon: of whose sounds is made isinglass, a kind of glue used much in physick. This fish is here in great plenty and in some rivers so numerous that it is hazardous for canoes and the like small vessels to pass to and again, as in the Pechiscut River to the eastward.

"The sting-ray: a large fish of rough skin. Good to cover boxes, hafts of knives and rapier sticks.

"The turtle: of which there are three kinds. 1. the land turtle. They are found in deep, sandy banks under old houses and



North Carolina tidewater Indians fishing, as painted by John White, Governor of the Raleigh Colony, about 1587 (left). Algonquin fishermen use paddles to propel dugout canoes, boat their catch with multi-pronged spear. One artist's conception (above) of the many commercial fisheries that flourished along the Potomac River in George Washington's time. It is entitled Funny Fish, from the "General History of Druggs," published in 1712.

never go into the water. For the physick, consumption, and some say, the morbus Gallicus. 2. The river turtle which are venomous and stink. 3. The turtle that lives in lakes and is called in Virginia, a terrapin.

"The scarlet mussel: at Paschaway (Piscataqua), a plantation about fifty leagues by sea eastward from Boston, in a small cove called Baker's Cove, there is found this kind of mussel, which has a purple vein and pricked with a needle yields a perfect or scarlet juice, dyeing linen so that no washing will wear it out, but keeps its lustre many years. We mark our handkerchiefs and shirts with it.

"The cockle: a kind of cockle of whose shell the Indians make their beads called wompompoag and mohaicks. The first are white; the other, blue. Both orient and beautified with purple vein. The white beads are very good to staunch blood."

During the early 17th century, while the southern colonies struggled for survival, building an agricultural society which slowly pressed its frontier westward, the American fishing frontier became permanently established. Its boundaries extended from Cape Cod to Labrador with its hub in Boston. While the Puritan leaders were laying sound constitutional and legal foundations for the commonwealth and the merchants were working at widening the area of supply for export, the shipbuilders, sea captains, and mariners were extending early American commerce far into the Atlantic.

It was during this period that fisherman were considered so important to the well-being of the colony that they were exempt from military service. In 1641, to encourage fishing, the government of the Massachusetts Bay Colony decided to pay field hands to replace farmers who went to work in fisheries.

"Because fishing is the chief staple commodity of the country, therefore, all due encouragement to be given unto such hands as shall set forward the trade of fishing; and for that end a law to be made: That whosoever shall apply themselves to set forward the trade of fishing, as fishermen, mariners and shipwrights, shall be allowed, man for man, some one or other of the labourers of the country, to plant and to reap for tthem, in the season of the year, at the public charge of the commonwealth for the space of the seven years next ensuing; and such labourers to be appointed and paid by the Treasurer of the commonwealth."

While commercial fisheries did not develop for several centuries in the southern colonies, local fish catches did contribute to Jamestown's survival by preventing starvation many times in the cold winters. The tale is told in the writings of Capt. John Smith:

"1607. It pleased God, after a while, to send those people which were our mortal enemies (Indians) to relieve us with victuals, as bread, corn, fish, and flesh in great plenty, which was the setting up of our feeble men, otherwise we had all perished.

"1607. Our victuals being now within eighteen days spent and the Indians' trade decreasing, I was sent to the mouth of the river to Kecoghtan (Hampton), an Indian town, to trade for corn and try the river for fish, but our fishing we could not effect by reason of the stormy weather. . . .Only of sturgeon we had great store, whereon our men would so greedily surfeit, as it cost many their lives.

"1609. So it happened that neither we nor they had anything to eat, but what the country afforded naturally. Yet of eighty who lived upon oysters in June or July, with a pint of corn a week for a man lying under trees, and (of) one hundred twenty for the most part living upon sturgeon, which was dried till we pounded it to powder for meal, yet in ten weeks, but seven died."

In spite of their lack of experience with New World adversity these undaunted first Virginians managed to survive with a bit of ingenuity. Like the Pilgrims, they lacked proper fishing gear, so they used whatever was available at the moment—frying pans. From *The Travels and Works of Capt. John Smith,* Arber and Bradley:

"A Distant View of Mount Vernon" painted by Chapman from the collection of Chauncey Stillman, Courtesy National Gallery of Art.

"We found . . . in diverse places that abundance of fish lying so thick with their heads above the water, as for want of nets, our barge driving amongst them, we attempted to catch them with a frying pan, but we found it a bad instrument to catch fish with. Neither better fish, more plenty of variety, had any of us ever seen in any place, swimming in the water, than in the bay of Chesapeake, but they are not to be caught with frying pans. But our boat by reason of the ebb, chancing to ground upon many shoals lying in the entrance (Rappahannock River), we spied many fishes lurking amongst the weeds on the sands. Our captain, sporting himself to catch them by nailing them to the ground with his sword, set us all a fishing in that manner. By this device we took more in an hour then we all could eat."

The fishing business was not important to later southern colonists. Settlers had plenty of fertile land upon which they could concentrate their energies, so were not interested in trying to overcome the handicaps nature imposed on the south's early fishing trade. The Chesapeake Bay had an abundance of fish, but the take had to be made during the warm months when these fish were prevalent. Preservation of large catches was the main problem. The warm, damp climate was a hindrance to the usual method of salting and drying, and salt for curing was hard to come by (except in New England where it was a natural resource).

Fish thus were a precious item in the South. An indication of this is found in the first American census, taken in 1624, which enumerated the fish supplies, mainly salt cod, on hand in the several Virginia communities.

Washington's fishing tackle is shown above, and at right is a view of recreational fishing from the Sportsman's Dictionary, 1735. Illustrations courtesy of the Mount Vernon Ladies' Association.

In 1612, Virginia cut off the ears of fisherman who didn't report catches of fish to the authorities. The second time an offender failed to make a report, he was sentenced to one year's rowing in the galleys (an open boat used in fishing) and the third offense condemned a man to the galleys for three years.

In Salem, Mass., punishments for theft of fish in 1774, as described by Coffin in *A Sketch of Newbury, Newburyport and West Newbury,* required the thief to parade through the streets holding a salt fish above his head, calling out, "I stole this fish and five quintals more."

In 1786 at Salem, stealing fish resulted in a sentence of "one hour on the gallows, be whipped 36 stripes and confined to labor on Castle Island three years." (Blooke, *Olden Times Series,* Vol. 5)

No fish story today is complete without some reference to sharks, and the colony's fishermen often had trouble with these "fishes larger than dogs." In a letter from Don Diego Sarmiento de Acuna to the King of Spain, in 1614, we find his candid comments on how sharks hindered his English neighbors at Bermuda. "In pursuing the pearl fishery within the sea, they meet on the coast of Bermuda with one great difficulty which has prevented them so far from fishing except on the coast, and this is the great quantity of certain fishes, larger than dogs, which it is said the English call from their form 'Jarques' and the latter say that they attack and at once dispatch any man. The English however, are also full of hope to catch them and clear the coast of them." (Brown, *The Genesis of the United States*)

The busy seaports of the Massachusetts

Tiburon!

Fernandez de Valdes describes some giant sharks being taken by trolling from ships: "When the ships are under sail, the biggest sort are taken after this manner. When the tiburon (shark) sees the ship sailing, he follows it swimming behind. The which thing the mariners seeing, cast forth all the filth of the ship into the sea for fish to eat, who nevertheless follows then with equal pace although they never make such haste with full wind and sales and wallow on every side and about the ship. Thus follows it sometimes for the space of a hundred and fifty leagues or more. When the mariners are disposed to take them, they cast down by the stern of the ship a hook of iron as big as the biggest finger of a man's hand of three spans in length and crooked like a fish hook with beard according to the bigness thereof and fastened to an iron chain of five or six links near to the end and from thence tied with a great rope, fastening also on the hook for a bait a piece of some filth or hog's flesh, or some other flesh, or the bowels and entrails of another tiburon which they may have taken before and which may be easily done, for I have seen nine taken in one day. If they would have taken more, they might also. Thus when the tiburon has pleasantly followed the ship a long voyage, at length he swallows the bait with hooks. As well as by his trying to fly or escape, as also by the swift passage of the ship, the hook overthwarts and catches hold of his chappes (jawa). The fish when it is taken is of such bigness that twelve or fifteen men are scarcely able to draw it out of the water and lift it into the ship. Whereupon one of the mariners gives it many knocks on the head with a club or bettle until he has slain it. . . . When they have slain this fish, they cut the body in small pieces and put it dry, hanging it three or four days at the cords of the sail cloth to dry in the wind and then they eat it. It is doubtless a good fish and of great commodity to serve the ships for victuals for many days. The least of these fishes are wholesome and tender."

Bay Colony provided most of the colonies' fishery activity. Fishermen there were skilled and productive, with several generations of expertise already at hand. During the 17th century, New England fisheries far exceeded all other trades in value. By the second half of the century, the industry had become so profitable for the church-going Puritans that, according to Harold Bradley in *The United States—1492-1877*, it had "produced a New England aristocracy based on wealth rather than piety. . . . The sea was more exciting than sermons, and pastors in port towns had cause to complain that some of their parishioners were more interested in the price of fish than in the price of salvation!"

Although the colonies were settled primarily in the interest of profit by private entrepreneurs from England, business per se did not expand significantly prior to the signing of the Constitution. The Eastern Seaboard colonies were primarily agricultural and operated low on the economic ladder. New England's early commerce had developed little more than financial independence from England. There was little hard cash in circulation, mostly foreign coins and English silver. The exchange which developed was a barter or trade system, relying heavily on credit. This bartering was centered, not surprisingly, on the developing fish industry.

Fish were used not only for "foreign trade," but—from 1648 to 1659—as a medium of exchange for individual transactions. In the *Suffolk Deeds:* "1648. If he pays or cause to be paid . . . twelve pounds in mackerel . . . then this deed is to be void.

"1650. We acknowledge ourselves to be indebted . . . the full sum of five hundred forty-seven pounds, ten shillings to be paid . . . in good merchantable dry codfish at the current price of the country and to be delivered upon the rock.

"1654. The said Davidson told me he had his part in fish in the hands of Mr. William Browne of Salem and would be ready at any season to pay it with one year's interest.

"1659. The sum of fifty pounds . . . due to be paid to the said Francis Smith, his heirs, executors, administrators, or assigns by the value thereof in fish and train oil."

Fish had become money.

In *The Writings of George Washington,* we find numerous references to his efforts to procure necessities through exchange of Mt. Vernon herring.

"Mt. Vernon, September 29, 1770. Sir: In return for the herrings (which will be shipped as a joint stock by M. Campbell and myself), you will please to bring me the following articles: 1 hogshead of good rum; 1 barrel of good spirits; 200 lbs. of coffee; 100 lbs. of best single refined sugar; 100 lbs. of best double refined sugar; 100 to 200 oranges if to be had good. The balance of my half of the sales of the herrings you will please to bring me in cash, and of such kinds as will pass here without loss. I wish you a pleasant and prosperous voyage and safe return to your owners and friends."

Further emphasizing the value of good fish, in 1758-69, payment to Mr. John Tuck, the minister of a New Hampshire community, was made in salt cod. In turn, he may well have used it to barter for his necessities.

It was during this period that the income from oyster grounds was given to the New Haven Colony to start a college which later became Yale. Benjamin Trumbull's *Complete History of Connecticut* contains this passage: "1660. Sundry years past, it was concluded by the said general court that a small college, such as the day of small things will permit, should be settled in New Haven for the education of youth in good literature, to fit them for public service.

"He (Governor Hopkins) desires of New Haven town that the rent of the oyster shell fields, formerly separated and reserved for the use and benefit of a college, be paid from this time forward, towards the making of some stock for disbursements of necessary charges towards the college till it be set up, and afterwards to continue for a yearly rental as belonging to it under the name and title of college land."

Fur traders soon found that the Indians were more impressed by clamshells than they were by gold coin. The clams which the Indians called wampum weren't ordinary clams, but a sort of periwinkle shell *(Venus mercenaria)* mentioned earlier, a type found in the Long Island area. The black or purple in the middle of the shell was valued more than the white edge. The shells were strung into several lengths, the more common measure being a fathom; a costly bargain would require many fathoms. New York colonists valued this wampum right along with Spanish and English silver, and its commercial value was set in the laws of the colony. "It is ordered that wampum shall pass current in the payment of debts to the payment of forty shillings; the white at eight a penny, the black at four, so as they be entire, without breaches or deforming spots . . ."

In those days of clamshell commerce, a great deal of trade was carried on by use of fish. Fish could be caught, sold, traded, pounded into fertilizer, or melted into oil—and when the going got rough, this finned friend could always be eaten.

Epilogue: A century later, the following motion was passed by the House of Representatives, Boston, March 17, 1784: "Mr. Rowe moved the House that leave might be given to hang up the representation of a cod-fish in the room where the House sit, as a memorial to the importance of the cod-fishery to the welfare of this Commonwealth, as had been usual formerly."

The codfish hangs in the chamber of the House of Representatives of the Commonwealth of Massachusetts.

A renowned NOAA scientist speaks out on a major national concern

Ozone and Its Enemies

Dr. Lester Machta, Director of NOAA's Air Resources Laboratories, was interviewed by Carl A. Posey

Q. Dr. Machta, much is being written about ozone in the stratosphere, what it means to humanity, and what humanity may be doing to it. In discussing this, I'd like first to have you set the stage by describing the stratospheric environment.

A. The stratosphere is a layer of the atmosphere that has its base at about 30,000 feet in polar regions, and about 55,000 feet in equatorial regions. The top of the stratosphere differs depending on which scientist one talks to. By and large it is thought to cease at about 150,000 feet. It differs from the troposphere, which lies below it, in that the temperature remains constant or increases with altitude in the stratosphere, whereas in the troposphere below it decreases with increasing altitude. The second important difference between the troposphere and stratosphere lies in the absence of clouds in the stratosphere. Most cloudiness—weather as we conventionally understand it—occurs in the troposphere, with the stratosphere being almost cloud-free.

Q. Would you characterize the stratosphere as a harsh environment?

A. It would be harsh only in the sense that there is very low pressure there, so that one would be unable to live in it and breathe naturally. It would be very cold and in some regions the winds would blow fairly hard.

Q. Why would ozone be more plentiful there than anywhere else in the atmosphere?

A. Ozone is formed when ultraviolet solar radiation shines on oxygen, and dissociates it, producing a single oxygen atom instead of the usual O_2 [molecular oxygen, made up of two oxygen atoms]. This oxygen atom recombines with ordinary oxygen molecules to form ozone, which is O_3. So only in the stratosphere is there enough ultraviolet radiation to produce ozone by photodissociation of the oxygen.

Q. Why is this layer of ozone important to us?

A. Well, for a number of reasons. As meteorologists—and long before there was any of today's ozone scare—we recognized ozone as being a major absorber of solar radiation that determines the climate of the earth and particularly the climate of the stratosphere. More recently we have come to appreciate the fact that ultraviolet radiation can be damaging to life near the earth's surface, and that the ozone, in absorbing that radiation, prevents much of it from reaching the surface. Without an ozone layer to shield us from short-wave ultraviolet radiation, we would probably not have life on earth as we know it now.

Q. The term "ozone layer" suggests a kind of shell of approximately uniform density and thickness. Are those its real properties?

A. More or less. In the troposphere, the ozone values tend to be relatively low compared to the stratosphere's. The higher values lie in the stratosphere. The maximum concentration occurs at about 80,000 feet, being a little lower near the poles than

it is in the equatorial regions. These values also fall off toward the tropopause—the separation between the troposphere and stratosphere—and with increasing height above 80,000 feet. So this describes the change with altitude.

As far as change with latitude is concerned, the ozone thickness increases generally as one goes toward the polar regions and has its minimum values, surprisingly, in the equatorial region—despite the fact that it is in the equatorial region that we have our most intense sunshine, and most of the ozone is formed.

There also is a pronounced seasonal variation in both hemispheres, with the largest amount of ozone being present in spring and the minimum amount being present in autumn.

Q. Is it also patchy in its horizontal distribution?

A. Yes it is. There have been many meteorological studies showing, for example, that as a low pressure system, or storm, passes a station one has low readings of ozone before the passage and high readings after the passage. So there are horizontal inhomogeneities in the ozone content.

Q. Have these been explained?

A. Yes, they've been explained for about 30 years, since the instrument was invented that measures ozone.

Q. But apparently there are still many unknowns regarding ozone in the atmosphere?

A. Specifically, if you consider an atmosphere that has only oxygen and hydrogen, we cannot with our theories of photochemistry and ultraviolet radiation explain the observed amount. There appears to be too little ozone present. It's been speculated that the substances which destroy ozone and produce the balance are nitrogen oxides: nitric oxide [NO] and nitrogen dioxide [NO_2].

Q. The impression one gets is that ozone has no friends, chemically speaking. Is it a highly reactive substance, and does that account for its being easy prey for some chemical compounds?

A. The answer is very clearly yes. Contact with clouds, the earth's surface, and so forth readily destroys ozone. It's very reactive.

Q. Let's talk now about an enemy of ozone, nitric oxide. Where does nitric oxide come from and how does it attack ozone in the stratosphere?

A. According to prevailing theory, nitric oxide, whose atoms are nitrogen and oxygen, is a result of nitrous oxide—N_2O—which evolves from the earth's surface by denitrification of material that's used in plants—fertilizers, and so on. This N_2O is very stable and unreactive in the troposphere and is able therefore to mix upward into the stratosphere. Once it reaches the lower stratosphere, where there is short wave ultraviolet radiation, it dissociates and forms nitric oxide—NO—and it's this destruction by NO which is thought to produce the balance between observed ozone quantities and what the theory calls for.

Q. So this attack is part of a natural ozone limiting cycle, not a man-developed problem.

A. That's correct. The so-called Gaia hypothesis, advanced by Dr. Lovelock of the United Kingdom, theorizes that atmospheric composition is determined by the biosphere, which alters the composition to ensure its survival. That is, plant life might be producing the right amount of N_2O to destroy just the right amount of ozone, so that just the right amount of ultraviolet radiation is received at the earth's surface.

Q. Are there other natural sources of nitric oxide?

A. There are other natural sources that come sporadically. One of them is galactic X-rays that seem to be modulated by the eleven-year solar cycle. The second is a sporadic production of nitric oxide by solar proton events, which mainly produce nitric oxide around the geomagnetic poles, from whence they spread out. The effects vary greatly with the intensity of the solar proton event.

Q. Do such sources tend to destabilize the natural cycle?

A. This is as yet an unknown. According to a theory developed by Drs. Paul Crutzen and George Reid [of NOAA's Aeronomy Laboratory] intense solar proton storms should have a marked influence over the amount of ozone in the atmosphere. And, indeed, scientists at Lawrence Livermore Laboratory have found a statistical reduction of ozone, following 52 solar proton events. However, there was one major proton event in August 1972 and the evidence of the total ozone measurements does not clearly suggest that the solar proton event caused a change in total ozone.

Q. What about man's contribution? Are we beginning to supplement the quantities of natural nitrogen oxides in the atmosphere—for example, through the increased use of chemical fertilizers?

A. Dr. McElroy of Harvard University estimates that about 15 percent of the nitrogen fixed by all processes, which later converts into nitrous oxide, and then to nitric oxide, is produced by manmade fertilizers, even today. He predicts this will increase very significantly toward the end of this century. It is on this ground that he is very concerned as to whether or not manmade intervention in the natural nitrous oxide cycle with fertilizers will in itself reduce the ozone layer.

The other way in which man can supplement the quantity of nitric oxide in the atmosphere is through combustion of the kind found in jet engines. Whenever air with nitrogen and oxygen is heated to high temperatures, as it is in jet-engine combustion, the nitrogen and the oxygen combine to form nitric oxide. This is done by industry at the earth's surface and it is done in the stratosphere by aircraft that fly there.

Q. Now let's turn to the so-called fluorocarbons. What would be a better generic name for them?

A. The fluorocarbons that we're talking about contain carbon, chlorine, and fluorine, so the name that is proper for them would be chloro-fluorocarbons. They're also called chloromethanes because the carbon atom has four other atoms attached to it. In one case these four other atoms would be three chlorines and one fluorine, in another case, two chlorines and two fluorines. Methane itself has one carbon and four hydrogen atoms attached to it, so the hydrogen is replaced by chlorine and fluorine in these compounds.

Q. How do they enter the atmosphere?

A. They enter by man's activities, either intentionally, released by aerosol spray cans, or accidentally, as in their usage as the gases for refrigeration and air conditioning equipment, when leakage occurs or the equipment itself is destroyed and the gas leaks into the atmosphere. A very small amount enters the atmosphere as a result of the use of fluorocarbons as a blowing agent in foaming polyurethane.

Q. Once in the atmosphere, where do they go and how long does it take them to reach the stratosphere?

A. Once they get into the atmosphere, despite the fact that their molecular weight is much greater than that of air—of the order of 130 to 150 molecular weight compared to 30 for air—they nevertheless mix thoroughly and become virtually an ordinary constituent of the atmosphere. So they enter at ground level, mix through the troposphere just like any other constituent of the atmosphere might mix, and then enter the stratosphere. The prevailing theory is that they enter the stratosphere mainly through the equatorial region. This is rather a slow process and it may take a matter of years for a substantial amount of the material released at ground level to enter the stratosphere. The process whereby the fluorocarbons are photodissociated takes even longer, because the materials have to mix up into the middle levels of the stratosphere.

Q. Do they enter at the equator because of large vertical storms there?

A. Probably so. Or the Hadley Cell, which is a circulation in which air from about 20 or 30 degrees north and about 20 or 30 degrees south converges at the equator at lower levels and rises in the equatorial region, may cause the upward current that penetrates the stratosphere. This is a matter of speculation.

Q. Flurocarbons are used as aerosol can propellants and refrigerants partly because they're chemically inert. What is there about them that makes them destructive of ozone?

A. The fact that they contain chlorine. Once these chemicals, which I'll identify as F-11 and F-12—and they are the only two fluorocarbons at issue now—once these rise

to altitudes of about 75,000 feet or higher ultraviolet light photodissociates the fluorocarbon and releases a chlorine atom into the atmosphere. The chlorine atom very quickly destroys an ozone molecule and forms chlorine oxide. Then the chlorine oxide reacts with atomic oxygen, again freeing the chlorine atom which destroys another ozone molecule. This cyclic destruction of ozone molecules by a single chlorine atom is called a catalytic process. The fluorocarbons themselves have no effect on the ozone whatsoever. It's the chlorine that's released when the fluorocarbons are broken down by ultraviolet light that causes the damage.

Q. You said you were only looking at F-11 and F-12. Is there a whole family of fluorocarbons?

A. Yes, there are very many fluorocarbons present that are used commercially. The reason the others—for example, F-22, which is also a refrigerant—apparently do not offer the same hazard to the stratospheric ozone layer is that they have a different chemical composition. Many of them have hydrogen atoms in them in addition to carbon, chlorine, and fluorine, and many of them have chemical bonds which are different from those in F-11 and F-12. What happens is that in the troposphere gases with hydrogen atoms or two or three other types of bonds are dissociated by OH (oxygen-hydrogen) radicals so that the chlorine is found in the form of hydrogen chloride. And hydrogen chloride is very soluble so that it washes out of the troposphere with rainfall and little if any of it gets into the stratosphere.

Q. So these are really much less inert than F-11 and F-12.

A. That's correct. When industry is looking for substitutes, should there be a ban on fluorocarbons 11 and 12, they will probably look at those with hydrogen atoms which, as you say, are less inert.

Q. Where is science now in terms of establishing whether this chemical attack on ozone actually takes place in the stratosphere?

A. The primary basis for the prediction is still theoretical modeling. In laboratories we can perform certain chemical reactions. When the rates of these chemical reactions are placed into numerical models, and everything else we need—meteorological transport, natural solar radiation—is introduced into the hypothetical model, we end up with a prediction of a certain amount of destruction of ozone by a given amount of fluorocarbon. However, in recent months there have been some bona fide field measurements in the stratosphere which tend to support the models. Such measurements have been made by the Aeronomy Laboratory of NOAA and by the National Center for Atmospheric Research. In this case, samples of air have been brought down from the stratosphere and analyzed at ground level. Dr. Paul Crutzen has made predictions of what the concentrations of these two fluorocarbons should be in the stratosphere and it turns out that the observed concentrations fit those which have been predicted by Dr. Crutzen and other people remarkably well.

Q. Are there some missing players, for example, some oxides of chlorine, and are they detectable with present technology?

A. One of the reasons I think we cannot say the theory of fluorocarbon destruction of ozone is completely proven is that we have not yet measured and shown that chlorine oxide is indeed present in the stratosphere. There are some uncertain data suggesting that possibly it's there. On the other hand, one of the other chlorine compounds that forms when fluorocarbons or other carbon-containing compounds dissociate is hydrogen chloride. This has been measured by Dr. Lazarus of NCAR and it turns out that the profile of concentration with altitude and the absolute values again fit remarkably well the kind of model that Dr. Crutzen and others have been propounding. This is something that's of special interest because many people think that the source of chlorine for the stratosphere should be sodium chloride, which comes out of sea spray. So much more sodium chloride is released to the atmosphere than what man does with fluorocarbons that one could argue against our worrying about fluorocarbons. Well, it turns out that sodium chloride from sea spray is very soluble and gets washed out in the troposphere. The proof that it is not a significant factor for the stratosphere derives from the fact that the profile of hydrogen chloride increases with altitude above the tropopause, contrary to what you would expect if the source were coming from below.

Q. Until the fluorocarbon issue was raised, I doubt most people knew a fluorocarbon industry existed. What does this industry comprise?

A. It's two parts. First, the industry that produces the fluorocarbons. Secondly, the users of them, such as the cosmetic industry and the refrigeration industry.

Q. How much does the United States produce of total world fluorocarbons?

A. It's generally accepted that, of the fluorocarbons 11 and 12, the U.S. releases into the atmosphere approximately half that which is released by the world, although we have a much smaller fraction of the world population. It may be of interest to you to know that about 85 percent of fluorocarbons in aerosol spray cans are used for two purposes—hair products, and underarm deodorants and antiperspirants.

Q. Much has been made of the fact that these ozone-related issues were raised in response to results obtained with computer models. How good are the models at approximating the real world?

A. Well, up until perhaps six months ago I would have said not very good. But in more recent months, as a result of the measurements made by our own Aeronomy Lab and other groups of the fluorocarbon distribution in the stratosphere and the hydrogen chloride, I now have a feeling that the models are being vindicated and are fairly good. Despite this, I think one should still have reservations. These models have to contain the distribution of many quantities such as OH radicals and other radicals in the stratosphere which have never been measured. They are estimated from other measured quantities. And it is conceivable, though now less likely, that the models fall into error as a result of using incorrect numbers for those and also possibly incorrect numbers for the rate reactions. Since Dr. Rowland first proposed the concept that fluorocarbons could destroy ozone in June of 1974, there have been several new rate reactions which have altered slightly the quantitative estimates of the predictions, and this probably will go on in the future to a certain extent.

Q. It obviously would be preferable to have actual measurements of these quantities. Why are they so hard to obtain?

A. Primarily I would say because the concentrations are exceedingly small. For instance, the fluorocarbons themselves are present in parts per ten to the tenth—one part of fluorocarbon to ten billion parts of air. And some of the OH radicals and other things we need to measure have equally small concentrations. We simply have not yet developed instruments that can be carried aloft that are capable of performing the job.

Q. Are these proportions about the same all the way up into the stratosphere?

A. The proportions of the fluorocarbons remain about constant through the troposphere, and through the lower stratosphere. Then, as a result of photodissociation, both theory and observations indicate a sharp decrease with altitude so that above about 70,000 feet there is a fairly substantial decrease.

Q. Can ozone, fluorocarbons, nitric oxide, and other substances of interest here be sensed remotely, from the ground or by satellite?

A. The nitrogen oxides can be measured by instruments on satellites. Nimbus 6 has several experiments. The fluorocarbons cannot now be and I suspect that most of the other radicals, which are present in very small concentrations probably cannot be sensed remotely either, at least not with present technology.

Q. Can the critical chemical reactions be duplicated in a laboratory?

A. Yes. In fact, except for a few that are a little more diffcult and need more checking or are still to be done, virtually all of the critical rate reactions used by the modelers are based on real laboratory reaction rates, not hypothetical rates.

Q. Are new technologies springing up around the problem?

A. Yes. Let me mention one NOAA itself has generated. In order to analyze for fluorocarbons we wanted to bring samples of air down to the ground. The Aeronomy

Laboratory decided to do this in a relatively inexpensive way. They took what is equivalent to two hemispheric steel salad bowls, cleaned them out on the inside, sealed them together, put a valve on them, and flew them on small weather-type balloons to very high altitudes. There, the spheres opened automatically, took air samples, sealed themselves, and parachuted back to the ground. This new technology has permitted scientists to analyze not only for the two fluorocarbons at issue, F-11 and F-12, but also for nitrous oxide. The Aeronomy Lab has also modified the electron capture gas chromatograph, which is the instrument used by most people to measure the fluorocarbons, so it can also measure nitrous oxide, and this is quite a new achievement.

Q. Atmospheric sinks might soak up or destroy atmospheric chlorine before it could attack ozone. What are sinks, and what evidence is there they exist for fluorocarbons?

A. By a sink we mean some process that removes the material from the atmosphere. For example, the process by which dust washes out of the air with rain or snow is a sink for those particles. As far as fluorocarbons are concerned, there are three or four sinks, but all of them have been deemed to be negligible in terms of destruction of fluorocarbons. First, there have been measurements of fluorocarbons in the ocean; but when you integrate the total amount in the water compared to what's in the air only a small amount is present in the ocean. Second, fluorocarbons have been measured in the ice at Antarctica; but, again, the quantities are quite small. Third, if air passes through the furnace where the temperature is more than about three or four hundred degrees Celsius, the fluorocarbons will be dissociated; but not much air passes through such high temperatures. Theoretically and by empirical observations, we don't think there are large sinks for the fluorocarbons in the lower atmosphere.

Q. Are there other compounds that could threaten the ozone layer?

A. Yes, there are several. Earlier we mentioned the oxides of nitrogen, and we've talked about the chlorine from fluorocarbons. Other halocarbons—the halocarbons being chlorine, iodine, bromine, fluorine, and so on—are all capable of destroying ozone in the same way that chlorine destroys ozone. In the case of the fluorine which I haven't stressed at all although relatively large amounts are going into the stratosphere as fluorocarbons—it turns out that hydrogen fluoride is formed very quickly and acts as a sink for the fluorine in the stratosphere. So we really pay very little attention to the fluorine. Not very much iodine is used in substances which get into the stratosphere. But bromine has been identified as a potential bad actor. Hydrogen bromide, which should be the main sink for it, is not formed in large amounts in the stratosphere. Fortunately, up to this time, it's estimated that only small amounts of bromine have been released in compounds that can enter into the stratosphere, in part because brominated compounds are rather expensive.

Q. Could there still be another critical reaction reported next year, or a decade hence?

A. If I had to make a prediction now I would say yes, but quite frankly I don't know what it is.

Q. One sometimes hears that next year it'll be something else, suggesting something whimsical in identifying this kind of environmental problem. Do you think emotion has had much force in the way this issue has evolved?

A. It's difficult to get behind the true motivation of some of the scientists involved. From my personal contact with them I would say definitely not, they all are very responsible persons. I think many of them have the feeling they wish they were wrong, so they would not upset the economy. Nevertheless, they all feel that if the theory is correct—and it's now looking as though the fluorocarbon predictions are correct—society must take proper action to prevent the damage that might result if the ozone layer were depleted.

Q. How do such environmental issues evolve?

A. Before the issue was raised in a publication in June 1974, it was well known that chlorine would deplete the ozone layer. The propellant proposed for the forthcoming space shuttle would have produced hydrogen chloride, which in turn would produce chlorine oxide, so the scientific community had reason for concern. The fact that there might be another source of chlorine in fluorocarbons really came about in a very strange way. Dr. John Miller of my office went to a meeting in Fort Lauderdale in January of 1974 and said in the presence of Dr. Rowland that we had a tracer—the fluorocarbons—that would be completely inert in the atmosphere and would not dissociate at all. We also pointed out that the amount of fluorocarbons in the atmosphere was growing rather rapidly. As a consequence of Professor Rowland's being at this meeting, he immediately associated the photodissociation of fluorocarbons with the potential for producing chlorine oxides, and his paper about six months later was the result. After he published his paper, which was relatively straightforward, others supported it with more complex models and also recognized other substances such as the bromine compounds which might have a similar effect.

Q. Looking now at the ozone shield itself, is it possible to monitor the rate of ozone removal—for example, from stations in the Geophysical Monitoring for Climatic Change network?

A. The answer would be yes if we waited long enough and sufficient amounts of fluorocarbon or some other destructive material were added to the atmosphere so that the reduction would be very large. The reduction of ozone would have to be at least five or ten percent lasting over many years before we could be sure that the decrease of ozone was due to manmade causes instead of natural variations. At the present time, the estimates from the models call for ozone reductions from the fluorocarbons of the order of one percent or less. This small amount of ozone reduction lies so much within the noise on a natural day-to-day, week-to-week, season-to-season, and year-to-year variability, that even if we did see a decrease we would not be able to assure anyone that this decrease was due to manmade rather than natural causes.

Q. Taking the worst case for fluorocarbons, how much ozone depletion could we expect over what period of time?

A. The calculations that people like Dr. Crutzen and others have made assume that the production or release of fluorocarbons made in 1972 would be continued indefinitely and that an equilibrium would be established. At that time the reduction would be of the order of ten percent after many, many decades.

Q. What if nitric oxide were permitted to increase significantly in the stratosphere, how much ozone depletion could we expect from that?

A. It depends on how much nitric oxide. For example, taking the fertilizer problem, Dr. McElroy estimates that for the fivefold increase in use of fertilizer that's expected by the year 1995, if the denitrification process releases nitrous oxide into the atmosphere, there will be about a 30 percent reduction of ozone due to that factor some years after 1995. Dr. Crutzen, who was the first to raise the question of nitrogen fertilizers and possible ozone destruction, takes quite a different view. He estimates that even with this increased use of nitrogen fertilizers, the worst possible case would reduce total ozone by only about half of one percent by the year 2000, and by perhaps eight percent by 2100. That is, he sees a potentially serious problem, but does not see the same urgency here as for the case of fluorocarbon removal of ozone.

Q. Would such destruction of ozone be permanent, or would new ozone be created in the lower atmosphere and migrate upward to reinforce the shield?

A. The ozone is really formed in the stratosphere. But ozone is being formed and destroyed constantly. What we observe in the atmosphere is the balance between the ozone being destroyed and the ozone being formed. When we add nitric oxides and chlorine compounds this equilibrium shifts to a slightly lower value. In terms of the fluorocarbons, the recovery time after we ceased the release of fluorocarbons at ground level would be very slow. The maximum depletion might not occur until ten years after you stopped releasing to the atmosphere. The recovery to a pre-fluorocarbon era level might take fifty to a hundred years.

Q. If ultraviolet radiation creates ozone in the stratosphere, why wouldn't it also create it in the lower atmosphere as the shield

weakens? That is, why wouldn't the net effect be simply a lowering of the ozone layer?

A. That argument has actually been included in the models that Dr. Crutzen and others have worked out. In many of the models, one does find a slight increase in ozone in the lower part of the stratosphere. However, the ozone reduction at higher levels is much larger than this lower-altitude increase. But yes, there would be greater ozone production in the lower stratosphere.

Q. As the ozone shield weakens, at what point would we begin to pay biological penalties?

A. This is a very difficult question. If one accepts the prevailing view that skin cancer is caused by ultraviolet radiation and that there is no threshold we have to reach before this relationship begins to operate, then we are paying a penalty immediately whenever the ozone is depleted for an extended period of time. One of the greatest concerns people have about ozone depletion is its effect on agriculture, and unfortunately the information is so sketchy that one is loath to make predictions. Photosynthesis has been reduced in greenhouse experiments when ultraviolet radiation is increased, suggesting that there would be a deleterious effect. On the other hand, in some field experiments an increase in ultraviolet radiation has produced no effects.

With regard to climate, the third area in which there might be an effect, we're again too uncertain in our predictions to be able to say whether there would be any change in climate for small ozone change.

Q. How urgent do you feel the problem is? Is time of the essence?

A. Well, if one takes the conservative view that there are skin cancers being formed by even the most trivial decrease in ozone and increased ultraviolet radiation, then one should remove the cause of this depletion as soon as possible. Back about a year ago when the federal government first took an interest in this, it was realized that we had only a theory and there was great uncertainty as to whether the theory was correct. We decided we should allow about three years for research. Dr. Crutzen and others made calculations to see what kind of penalty we might pay for delaying three years and it did not seem excessive, at least in the judgment of most of us. A year has already elapsed and considerable progress has been made in obtaining data of this sort. In addition to allowing time for research to prove or disprove the theory, the feeling was that industry should have an opportunity to look for substitutes for fluorocarbon 11 and 12. Although they are not announcing what their accomplishments may be in this regard, because of industrial security, there seems to be little doubt that they are moving rapidly ahead, as they properly should.

Our third argument for this three-year delay was that it would probably be necessary to provide this kind of time delay in order for regulatory agencies to take action.

Q. What steps do you see as essential in accomplishing the general scientific understanding of the stratosphere and the chemical reactions there?

A. Being specific to the fluorocarbon issue, I think it is necessary to find chlorine oxide and chlorine itself in the stratosphere before we can be very confident the theory is correct. We also have to make a very strong search for other sources of chlorine. For example, since Dr. Rowland's paper came out, Dr. Lovelock in the United Kingdom has suggested another even larger, apparently natural source of chlorine for the stratosphere—a substance called methyl chloride. And, indeed, a substantial amount of the natural ozone depletion may be occurring due to the presence of this substance in the stratosphere. It may be that there are other large chlorine-bearing natural compounds that are introducing chlorine into the stratosphere that would alter our judgment of what's going on there. The other aspect is the so-called sink in the stratosphere. If the chlorine oxides are not found in the stratosphere it may be that there is some way nature can remove them before they catalytically attack the ozone layer. One of these is the possible attachment of chlorine or chlorine oxide to particles, which would remove them from the chain of ozone destruction.

Q. Do you see a need for a long-term program that would look at the more general stratospheric picture?

A. Yes. I think our knowledge of the stratosphere clearly must be increased, on many scores. For example, the modeling of transport in the stratosphere must be increased considerably. Efforts along these lines are underway in my Air Resources Laboratories and elsewhere to try to obtain really inert tracers to determine transport in the stratosphere, and on a very advanced theoretical plane by NOAA's Geophysical Fluid Dynamics Laboratory at Princeton. These efforts will go on.

Secondly, we have to understand the chemistry of the stratosphere better than we now do. This involves measurements of many substances we now know to play a role—and some which perhaps play a role that we're not aware of. As we find these substances we're going to have to measure their chemical reactions to determine their importance in the stratosphere. For example, we are looking now at other chemical compounds that might get into the stratosphere. If they do get into the stratosphere, we have to determine what chemical reactions might be going on. This is an area in which I think a major effort will be required in the next few years.

Since my prediction is that other threats to the stratosphere are going to raise their ugly heads in the future, we should be in a position of being able to show either that they are real, or lay them to rest before the public is unnecessarily alarmed. We can do this only with a clearer understanding of physical and chemical processes in the stratosphere.

Dr. Lester Machta (right) receives a Special Achievement Award from NOAA Administrator Dr. Robert M. White.

Dr. Lester Machta is Director of NOAA's Air Resources Laboratory in Silver Spring, Md.

Dr. Machta, born in New York City, received his B.A. in mathematics from Brooklyn College in 1939 and his master's in meteorology from New York University in 1946. He became a civilian meteorology instructor in the Army Air Corps in 1941; in 1944, he entered the Air Corps continuing as an instructor. After discharge in 1946, Dr. Machta taught mathematics at the University of Illinois at Urbana, then entered Massachusetts Institute of Technology and received his Sc.D. in meteorology in 1948. He joined the U.S. Weather Bureau that year.

Dr. Machta has been recognized for discovering and solving a wide variety of environmental problems related to global circulation, climate, and pollution. He conceived and led a project to determine the world's oxygen supply which conclusively demonstrated no decrease in global oxygen content over the past 60 years. He has worked with scientists of other federal agencies and other nations on CO_2 monitoring programs, and has made what is probably the best prediction of what carbon dioxide levels in the atmosphere will be in the future. For the past 20 years, Dr. Machta has been the principal meteorologist working on problems of fallout with the Atomic Energy Commission.

For these and other scientific achievements, Dr. Machta has been honored with the Department of Commerce Exceptional Service Award (1957), the Environmental Science Services Administration's (an agency absorbed by NOAA in 1970) Special Achievement Award (1970), the American Meteorological Society's Cleveland Abbe Award for Distinguished Services to Atmospheric Sciences (1974), and the NOAA Award for Scientific Research and Achievement (1975).

Dr. Machta is a professional member of the American Geophysical Union, the Royal Meteorological Society, the American Meteorological Society, several World Meteorological Organization Working Groups, and holds membership in Pi Mu Epsilon honorary mathematics society and Sigma Xi Honorary Society.

NOAA Profile

"CALL ME LENA!"

BY VALERIE ANDERSON

Photos: Harold M. Goodman

What good is mathematics?

This question, asked by a college freshman of a young and inexperienced teacher, started a chain of events which brought to NOAA one of its valued computer experts.

Unable to answer the question, the Southern University teacher left her job and set out to find the answer. It came to her slowly—but finally, in her new career with NOAA, she discovered—by getting out into the world and meeting people—that mathematics is interwoven into nearly every walk of life.

Leaving behind three years of teaching in Baton Rouge, La., Lena Loman, now Chief of the Programming Support Section, of the Automation Division in the Services and Applications Branch at the National Weather Service's National Meteorological Center in Camp Springs, Md., came to NOAA in 1957 as an "operator/programmer."

The Programming Support Section Lena heads writes the programs—instructions to the computer in a certain order to achieve a particular result.

NMC provides basic weather analyses and forecast guidance for use by field offices in informing the public of the weather. It also provides an increasing number of meteorological end-products, such as wind forecasts for aviation and precipitation forecasts for hydrology and public services.

Raw data is received into NMC's Computer System via high speed and low speed (teletype) communications lines from all over the world. The inflow (and outflow) of this data, which has a lifespan of 6-12 hours, is controlled by a special programming system. This system consists of an intricate set of programs which read the information at the beginning of each incoming block of data to determine its destination.

"At specified times during the day large blocks of the raw data are transferred into NOAA's central system for further processing," explains Lena. "By this time quite a bit of 'clean-up' has been done to the data to make sure that it is usable. As soon as this data has been 'analyzed' it is ready for input into the various forecast programs by which NMC makes its forecasts of the future state of the weather."

Products from NMC are not "local forecasts." These are generally produced at the various local weather stations around the globe. The NMC products depict weather over the entire Northern or Southern hemisphere or over the tropical belt (a strip around the equator) and are used strictly as guidance material.

What has all this to do with Lena's section? Its work depends on this data base.

"We become heavily involved in the programming from the time data is 'dumped' into the central computer system until the required end-products have been produced," says Lena. "The programs on the central computer are linked together in a series of 'networks' to make certain they are executed at the proper time. This is because often the end results of one program become the input for another program. Also, certain products are required to be completed by specified times."

"The programs," she says, "must be kept current and trouble-free. The products must go out."

A large part of NMC's programming effort is devoted to getting information such as windspeed and direction and temperatures into a usable form—such as bulletins for transmission to Weather Service Offices, or maps printed or plotted on predefined grids.

"We are continuously looking for ways to improve the products," says Lena. "We try to keep abreast of developments in the computer industry as well as with new ideas coming from the research staffs. The computer system NOAA now has at its central site is a very complicated system. We are making major changes in some of our programs to reduce the chances for errors."

The weather prediction NMC performs is an international effort. NMC is the U.S. hub of the World Meteorological Organization, a United Nations agency that exchanges weather data. All information received as well as some of the processed data is redistributed to WMO member countries.

To assist NMC programmers and other persons in NOAA, Lena and her staff maintain a library consisting of "general use" programs, program documentation, manuals about the computers, and some books. The programs are kept on disks (a high-speed storage device for the computer) for easy access. Some teaching material is kept for use when training new personnel.

She began her career with NOAA by receiving on-the-job training to operate and program NMC's computers.

"I learned on the job and went to IBM schools, or took classes from IBM instructors," says Lena. "Today people entering this profession have some type of computer background. People now major in computer science in college and don't need extensive training on the job. The computers may be different, but the concepts are the same."

Training is a part of Lena's job today. Although her primary job is supervision of about a dozen people, she comes in contact with and provides assistance to all new programmers entering NMC.

"The NMC trainees who are part of NOAA's Upward Mobility program come under my tutelage. If I don't do the training myself, I set it up. Knowing that I already had a teaching background and that I like to do it, I was given the opportunity to teach. Teaching is my first love," she says.

Her ability to get along with people informally shows in her accomplishments with Equal Employment Opportunity within NOAA. She chaired EEO committees of both the National Weather Service and NOAA in 1974. During this period, major EEO activities were initiated, including the Scientific Upward Mobility Training program, EEO Awareness Day ceremonies, and special commemoration by NOAA of Martin Luther King's birthday.

Lena was recently awarded a NOAA EEO Award for her accomplishments in this post. When EEO activities conflicted with the demands of her work, she devoted her own time to EEO affairs. Her dedication to the task, said the nomination statement, "has inspired supervisors to make every effort to place minority and women candidates in important jobs."

Top-level NOAA officials have said that Lena possesses a fiber which has helped in her efforts with EEO. She feels that when dealing with something she believes in that she will do anything possible to try to convince people to do something about it. She has no qualms about talking to people in upper management. She enjoys the challenge of negotiation and does not hold high officials in such awe that she feels them to be unapproachable. She does not hesitate to try to get her point across, and although they don't always agree they do listen.

(Top) Lena in one of her many training sessions; (bottom left) helping Billie Struble, a computer programmer, with a problem; and (bottom right) at work in her office with her supervisor Harold Bediant.

"EEO is an outgrowth of my general love for people," says Lena. "I like to see people happy. It bothers me to see people in an unhappy situation. I don't know if it's because I've been happy nearly all my life. Too many people can't say that.

"I like people. I guess that's why I've always liked to teach. I just love to talk; this probably is a result of my home life.

"My family, particularly my father, have always been Bible believers. Dad always taught us to love and never to hate. He would not allow any concept of hate or any low-rating of people. As a result of this, I learned not to be hampered by other people's prejudices."

A native Washingtonian, Lena came up through the District school system, beginning at old Stevens Elementary, today the oldest D.C. public school building still in existence.

"The Washington school system was segregated, but a very good one if you went through the academic line," says Lena. "The schools I attended had tremendous academic programs and very dedicated teachers—teachers who knew the only way for a member of a minority to make it was to get a good education. This was heavily stressed."

She started working as a babysitter at the age of 12, and then attended a high school which prepared her well for college.

(Top) At home with her family, Lena plays the piano, Donna the French horn, Lillian the violin, and David the trumpet; (bottom left) Lena plays the viola; and (bottom right) enjoys the fresh air in her backyard.

When she finished high school she got a job with the Civil Service Commission. The following two summers she taught swimming at camp.

When she entered Howard University, she wasn't sure of her eventual major. Her father, Harvard Brown, now a minister in Washington, encouraged her to continue her education in mathematics.

Lena received her bachelor and master degrees in mathematics from Howard University, but stresses the importance of having a versatile background:

"I learned as a child not to concentrate on one specific area. I thought it would be wise to prepare to do more than one thing. So I took enough courses in education so that if the opportunity to teach came first that would be what I would do. And it just so happens that's what I did."

"My father was very encouraging," continues Lena. "It so happens that his grandmother had finished high school, which was remarkable in those days—especially for blacks—although for anyone, really. My father had attended the University of Illinois after high school but was unable to continue because of financial reasons. So he encouraged me to continue my education in what I seem to enjoy most, which was mathematics."

In her senior year at Howard University, she decided to go on to graduate school:

"I loved school," says Lena. "I found it fascinating and a lot of fun, even when I wasn't doing well. The head of the math department at Howard had received a grant to continue research in mathematics. He needed a secretary and asked me to take the job. This allowed me to work part time when I returned to school, and to continue my education."

This encouragement gave her a confidence that has been important through her career.

"I've always felt that anything I really wanted to do badly enough I could do if I got enough training. Some people don't think well of themselves and don't realize their potential because no one ever encouraged them.

"The family background," she stresses, "has a lot to do with your personality, your outlook on life, and how well you get along with people."

This background of work, school, and family encouragement has enabled Lena to reach the position she has today. Not a women's libber, she arrives for work in floor-length dresses and feels women should remain feminine. Asked whether, she likes to be addressed as Mrs. or Ms., she flashes a bright smile and says, "just call me Lena.

"I like being a woman and I like the advantages of being a woman. I enjoy having doors opened for me by a gentleman, and my husband enjoys doing it. I am not against women's lib, I just haven't needed it."

The mother of three, she is an example of a successful working wife and mother. What little spare time she has is usually spent with her family in music. She, her three children, her sister, and her seven children all play musical instruments.

"Music is one other aspect of my home life that has made it so precious," she says.

She began playing the piano in 3rd grade, paying 25 cents a lesson. She went on in the eighth grade to play bass in the school orchestra which she continued through college.

She speaks of NMC as a rewarding place to work.

"I have been very fortunate. NMC has been a wonderful place to work for having people interested in you as an individual. Dr. (Frederick G.) Shuman, NMC's Director and my supervisor Mr. (Harold) Bedient, have allowed me to branch out in other areas such as EEO.

"I owe a large part of my career to my first supervisor, Arthur Kneer. He was always suggesting that I take a course or trying to get me involved in new areas. He allowed me to use my own ingenuity and my own ideas. I've always tried to be someone who if she saw something that needed to be done, would go and do it. And he was a supervisor who would sit down and listen to my suggestions."

Kneer, now a computer specialist in the Automatic Data Processing Management Planning Division in the Office of Management and Computer Systems in Rockville, Md., seems to think she did it on her own:

"Lena has integrity. She is very congenial and works well with people. She had a good grasp of the work she was doing and she didn't require much guidance. I enjoyed working with her."

And that seems to sum it up. Supervisors, employees, trainees looking to her for help, and people facing her across a conference table—they all enjoy working with Lena Loman.

A Tale of the Talking Tub

Floating Robots Monitor the Marine Environment

BY JOHN G. STRINGER

Known for the most part only as a mariner's aid to navigation, the humble buoy has developed within the past two decades into a technologically sophisticated data acquisition system used worldwide by government, industry and science.

- Two buoys were deployed in late October off Cape May, New Jersey in support of meteorological monitoring requirements for the New York Bight Project, which is examining the full range of man-ecosystem interactions in a heavily impacted coastal area.

- Hurricane Eloise, which struck just east of Destin, Fla., on September 23 at 7 a.m., provided a major test for two experimental data buoys located in the Gulf of Mexico. They reported wind speeds of 80 m.p.h. and wave heights of over 40 feet to the National Hurricane Center in Miami, Florida and to the National Weather Service in Washington, D. C.

- Riding the waves of the Pacific 344 miles southwest of Astoria Oregon is a 50-ton buoy containing sophisticated electronic gear to measure wind speed and direction, barometric pressure, air temperature, surface wave height and water temperatures.

- An automated data gathering buoy anchored for a three-month period last summer approximately 38 miles east of Ocean City, Md., monitored the effect on water quality of industrial and municipal wastes dumped at that site.

For over 200 years buoys have been used as aids to navigation. In recent years modern technology has made possible their use as floating observation stations that collect environmental data and transmit it to shore. They provide information of many kinds, to aid marine-related activities in transportation, offshore mining, offshore oil and gas production, fisheries, research, and recreation, to name some of the most important. Known as data buoys, each is a complete system. A data buoy consists of a buoy hull, moorings, environmental sensors, and electronics for telemetering the data to a shore station.

The NOAA Data Buoy Office (NDBO), located at the National Space Technology Laboratories in Bay Saint Louis, Mississippi, had its inception in 1967 under management of the United States Coast Guard. In 1970, the project was transferred to NOAA.

Buoy designed for continental shelf deployment rides the waves—designed for up to 4-knot currents, 100-knot winds and 45-knot waves. Known as Limited Capability Buoys, this type (sister buoy shown being loaded aboard Coast Guard cutter, page opposite) provides weather and oceanographic data automatically to shore stations.

NDBO is a developmental management organization consisting of approximately 50 civilian and Coast Guard personnel. Its purpose is to develop the buoy technology and prototype buoy systems. Contractors are used to carry out the various NDBO developmental projects and to refurbish, retrofit, and maintain the buoys deployed at sea. Coast Guard ships are used for buoy deployment, retrieval, and service trips.

Within the past several years, NOAA management recognized that a large network of multipurpose data buoys for all users was not a cost-effective way to provide marine environmental data. "Because there are so many kinds of users, with so many differing needs," said James W. Winchester, Director of the NOAA Data Buoy Office, "we concluded that a large network of multipurpose buoys was not technically feasible. Instead, we found the answer to be a family of buoys, each designed for a specific environment to acquire data for specific groups of users. With some overlap, there are three types that we work with—deep ocean moored buoys, continental shelf buoys, and drifting buoys."

One mission of the NOAA Data Buoy Office is therefore to develop buoy technology, and test and evaluate prototype buoy systems. The other is to procure proven systems and deploy and operate them as specified by user organizations.

Among the chief users of buoy data are weather forecasters. Meteorologists primarily involved in weather forecasting for such organizations as NOAA's National Weather Service, the U. S. Air Force's Air Weather Service, the U. S. Naval Weather Service, and industry require meteorological data at three hour intervals. They need data on the direction and speed of surface wind, sea level atmospheric pressure, air temperature, height and period of ocean waves, sea water temperature, and subsurface water temperatures to depths of about 500 meters. These data are useful for forecasts from almost any location in the deep ocean and on the continental shelf. However, the greatest need is from oceanic regions where storms tend to forms, and from data-sparse areas of the ocean, such as the Gulf of Alaska, where the environment is hostile.

Government, academic, and corporate groups involved in climate and oceanographic research are also users of data that can be collected by buoy systems. They need meteorological and oceanographic data acquired simultaneously from the same location over periods of a year or longer.

With the increased emphasis on offshore

exploration for petroleum products and mining from the deep ocean,, industrial groups are becoming users of buoy data. They require meteorological and oceanographic data taken simultaneously over a long period of time to establish engineering design criteria for construction of platforms and pipelines, and for drilling and ship operations. Data acquired from buoys during severe storms is extremely important to the construction of offshore oil platforms.

Federal and local government agencies responsible for coastal zone management and water quality are finding that data buoy systems are cost-effective ways to provide some of the data needed to carry out their missions. Both meteorological and oceanographic data are needed from the continental shelf, and water quality measurements such as water clarity, dissolved oxygen, pH, and chlorophyll are needed from estuaries. The data are used for site selection and for controlling and efficiently operating nearshore facilities such as harbors, piers, marinas, industrial plants, and sewage outfalls.

The basic elements of buoy technology and future research and development objectives of the NDBO program reflect a recent shift in the emphasis of developmental efforts to include drifting buoys and continental shelf moored buoys.

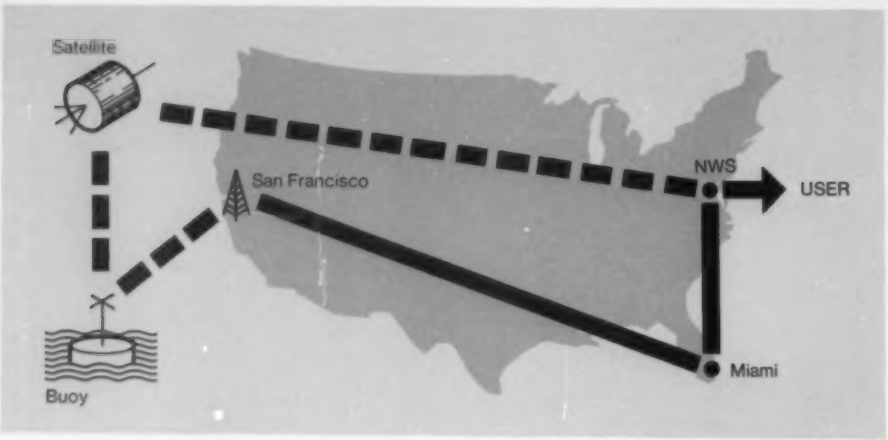
The NOAA Data Buoy Office has developed and deployed experimental data buoys in the deep ocean that provide the surface meteorological data that many users require. It demonstrated the feasibility of a two to three-year operation of these buoys in severe oceanic environments by deploying the first on a data station in 1971, about 250 miles off Cape Hatteras. The usefulness of the data collected by that instrument has been attested to by meteorologists from many nations.

Four of these large experimental buoys are currently at work: two in the Gulf of Mexico—one 187 miles south southeast of Gulfport, Mississippi and the other 240 miles south of New Orleans, La.; one in the Gulf of Alaska 185 miles southeast of Kodiak, and one 250 miles east of Charleston, S.C., in the Atlantic Ocean.

Data are collected by these buoys every three hours and immediately transmitted by radio to the U.S. Coast Guard radio station in either Miami, Florida, or in San Francisco, California. The San Francisco station serves as a relay between buoys in the Pacific and the Shore Collection Station in Miami, where all the data processing is done. After computer processing, the data are sent by landline to the National Meteorological Center at Suitland, Maryland, and from there disseminated nationally and internationally over the standard weather networks. All this occurs within one hour after the buoy collects the data.

When Hurricane Eloise struck just east of Destin, Florida, on September 23 at 7:00 a.m., it marked the first time that two large experimental data buoys were located in the path of the eye of a hurricane.

Paul Hebert, a meteorologist at the National Hurricane Center in Miami, said



Meteorological data from buoy to user—a schematic (above) of data transmission system. Arctic ice buoy (top right) operated for nearly two years in Arctic Ice Dynamics Joint Experiment (AIDJEX). A continental shelf buoy (near right) provides meteorological and wave spectra for MESA New York Bight and Bureau of Land Management cooperative program.

that the environmental data from the two buoys—EB-04 and EB-10, anchored in the Gulf of Mexico—documented important changes in the direction of the hurricane's track.

"The eye of hurricane Eloise," said Hebert, "passed EB-04 at approximately 9:00 a.m. on September 22 and over EB-10 at 9:00 p.m. the same day. During the passage of Eloise, both buoys continued to operate satisfactorily, and furnished valuable surface meteorological data every hour to our National Hurricane Center in Miami and the National Weather Service in Washington, D. C.

"These automatic data buoys," said Hebert, "measured wind speeds of over 80 and m.p.h.wage heights of over 40 feet. Other environmental measurements provided by the buoys were sea level atmospheric pressure, air temperature, and sea water temperatures."

Peter G. Black, a research meteorologist at the National Hurricane Center and Environmental Meteorology Laboratories in Miami, said that Weather Service aircraft data together with buoy data "allowed us to make comparisons of the winds of two altitudes. Up to now, there has not been any surface wind observation over the ocean.

"For the first time," he said, "we were able to estimate the wind profiles in the vertical."

Black, who is primarily concerned with the interaction of hurricanes on the upper layer of the oceans, said that the temperature measurements at the surface and at the surface and at the 50 and 200 meter levels were "fantastic." Data showed a dramatic decrease in surface temperature after the hurricane went by the buoy.

Among other important findings, the current meter at 50 meters and the surface meter attached to the buoys showed an oscillation that lasted for a month after Eloise had passed.

"It appears," said Black, "that the oscillation extended down 500 meters, and that the equilibrium of the ocean was not easily restored."

Duncan B. Ross, a research oceanographer at NOAA's Sea-Air Interaction Laboratory (SAIL) in Miami, made use of the wave spectra of EB-10 during Hurricane Eloise which provided an important source of data for his study that correlates wave height in hurricanes with surface wind speeds.

Using the data to compare to the predictions of a model developed by SAIL, Ross found generally good agreement except that when Eloise was moving slowly, the waves were somewhat higher than the model predicted.

"We can use this data," he said, "to incorporate the characteristics of the storm's velocity into the model. In other areas, such data can be used to improve design criteria for off-shore construction interests, and to predict wave-associated storm surge in critical situations."

The next step in NOAA's deep ocean moored buoy program was the deployment of the first of six prototype operational data buoys in the Pacific Ocean, about 344 miles southwest of Astoria, Oregon. Beginning this April, five additional buoys will be delivered at the rate of one per month.

The prototype operational buoy is somewhat smaller than the experimental buoy—ten meters in diameter rather than twelve meters as is the experimental model. The prototype buoy displaces about 58 tons, the experimental one 110 tons. Because it contains all solid state electronics, modular construction, and a hard-wired data processing unit, it can be battery powered, with sufficient battery capacity for three years of operation.

This prototype has the dual capability to transmit its data via radio using the high frequency band, or to relay the data through the Synchronous Meteorological Satellite-Geostationary Operational Environmental Satellite (SMS GOES), using the ultrahigh frequency band; but high frequency radio is

expected to be the primary means of transmission. Although the follow-on buoys will also have this dual capability, it is planned that the SMS GOES will become the primary communications and data transmission channel.

The research and development objectives for the deep ocean moored buoys are directed toward providing other kinds of data increasing the reliability of sensors and electronics, and reducing the total system cost. In the area of data enhancement, a project is underway to provide integrated temperature profiles of the atmosphere from the surface to an altitude of 500 to 600 meters by use of remote sensors located on the deck of the buoy. Plans are being developed to utilize proven satellite technology and to adapt satellite-type sensors to buoy use.

Remote sensing from satellites is accomplished by a downward-looking sensor; the process will be reversed in buoy use. Considerable success has been achieved in obtaining one dimensional (wave height) spectra, and the possibility of providing directional wave spectra appears to be good. In addition, an effort is underway to develop an ocean temperature sensor to obtain sea water temperature profiles from the surface to about 500 meters. All existing buoys are expected to be retrofitted with these added capabilities as they are tested and proven.

The NDBO program to develop and test continental shelf-type buoys for acquiring meteorological data began in April 1972. Three hull shapes, sensor types, and electronics packages have been tested and evaluated. Because the continental shelf environment is not usually as hostile as the deep ocean areas from which data are needed, the buoys need less rugged hulls, moorings, sensors, and electronics, and less total battery capacity. At-sea maintenance costs are less because of the shorter distance from shore.

Three continental shelf buoys in their initial developmental configuration were deployed for approximately six months off the west coast of Florida for a University of Miami and National Science Foundation atmospheric-induced shelf dynamics research project, and another buoy was deployed in the Santa Barbara Channel off Santa Cruz Island for the U. S. Navy.

The electronics and sensors from two other developmental continental shelf buoys have been integrated into 16-foot diameter discus hulls acquired from the Office of Naval Research and the National Science Foundation, and these buoys have been used in the New York Bight/Baltimore Canyon area, in environmental research projects.

One of the initial developmental buoys has been redesigned to acquire water quality data, as well as meteorological data. Last summer this buoy was moored for three months near the mouth of the Delaware Bay, approximately 38 miles east of Ocean City, Md., in a cooperative program with an Environmental Protection Agency laboratory that is monitoring ocean dump sites.

Objectives of the continental shelf buoy program are to develop the capability for acquiring water current velocities at all depths, to develop specialized electronic payloads and hulls for specific purposes, and to reduce total system costs. Valid water current velocity measurements may be obtained in three to five years on the continental shelf from reliable, truly operational buoy systems.

The drifting buoy program began in 1971 with the objective of demonstrating the feasibility of using an experimental polar-orbiting satellite for data telemetry and position determination from an unattended buoy designed to operate in arctic regions. The prototype buoy operated in the Arctic from October 1971 to March 1972. Its position and environmental data that it acquired were regularly sent to a ground station by the NIMBUS-4 satellite, utilizing an interrogation recording and location system.

In the second phase of this program, six of the buoys were set adrift in the Arctic Ocean in 1972 as part of an ongoing Arctic research study. Their useful life ranged from 75 days to 603 days.

Early in 1975, the NDBO completed the development and testing of three prototype ice buoys that use the Navy Navigation Satellite System for determining their geographic position. These buoys, which transmit their environmental data and their location by high frequency telemetery to a manned station on the ice, are capable of measuring relative ice motions to a position accuracy within hundreds of meters, compared to a two to five kilometer accuracy for polar-orbiting satellites. These buoys are now in use in the Arctic Ocean with the Arctic Ice Dynamics Joint Experiment (AIDJEX).

To support studies of ice behavior on the continental shelf and other areas, efforts have been initiated for an air-deployable ice buoy and an oceanographic and meteorological ice buoy. The air-deployable buoy will only provide its geographic position and is designed primarily for use in the marginal ice/water zone where information on ice movement is important to many planned operations. The buoy will track ice motion and relay data via the polar-orbiting NIMBUS-F satellite system. The oceanographic-meteorological buoy will measure barometric pressure and current speed and direction at two levels below the ice.

NDBO is also developing drifting buoys capable of measuring a basic set of simple meteorological parameters for use in the open ocean. Prototype drifting buoys have been successfully tested with the NIMBUS-F satellite launched in June 1975. Environmental parameters measured by the buoys are transmitted to the satellite, which in turn sends the data to a ground station. The satellite is able to determine buoy position by measuring doppler shift (relative velocity) between the buoy and the satellite. A system such as this is now believed feasible for large scale global atmospheric and oceanographic research programs.

These open ocean drifters are also used by oceanographers in a configuration that makes them suitable for tracking surface currents. At the present time, approximately 60 of these buoys are in production, to be used in more than 12 individual experiments. Components of this system are now being used by investigators in Australia, Canada, England, Norway and South Africa. During the Global Atmospheric Research Project (GARP) experiment to be performed during 1978 and 1979, as many as 300 meterological and oceanographic drifting buoys are planned to be put out by the Canadian and British investigators.

A major placement of these buoys is planned as part of an engineering experiment prior to the First GARP Global Experiment (FGGE). This engineering field test will demonstrate the feasibility of deploying drifting buoys from ships in the Southern Ocean, and will provide information on the surface currents along the deployment routes. Beginning in January 1976, more than 25 buoys will be put to sea.

An important aspect of the FGGE will be the observation of near-surface conditions (surface pressure and temperature) with a system of low cost expendable drifting buoys, communicating via polar-orbiting satellite. These buoys will transmit signals that will be received on a random access basis (without interrogation) by the satellite. The satellite will store transmitted data, together with sufficient information about the apparent carrier frequency of the buoy transmission, to enable the relative velocity between the buoy and the satellite to be computed. This in turn will permit determination of the buoy position. Most of the buoys will drift in latitudes extending from 20 degrees south to the marginal ice zones of the Antarctic continent.

The third type of drifting buoy under development is an air/sea interaction buoy. A number of large scale experiments covering very large oceanic areas are planned during the next few years to study the physical processes that lead to long-term variability in climate. Anticipating formidable observational difficulties in light of the large spatial coverage and density of observations required, a large variety of observations platforms, ships, and anchored deep ocean data buoys are expected to be used during these experiments.

According to Winchester, the NOAA Data Buoy Office has demonstrated the utility of data buoy systems for use in the total national marine environmental data acquisition program. "Data buoy systems," he said, "were never intended to replace other data acquisition systems such as satellites, ships, aircraft, or radar. Instead, data buoys complement them by obtaining marine environmental data that cannot be collected by satellites, aircraft, and radar, or even ships, at reasonable cost."

From the buoys in the Gulf of Mexico to those in the Arctic regions and the waters off the west and east coasts, the development of the data buoy system has been successful. The data buoy is on the way to taking its place for monitoring the marine environment along with satellites, reconnaissance aircraft and ships of opportunity.

A new award honors

The Dean of the Weather-Watchers

BY NANCY PRIDGEON

What do you give a man who's got everything?

That quandary faced the National Weather Service's Substation Networks Management Branch when Edward H. Stoll approached 70 years of officially reporting the weather from his farm near Elwood (pop. 601), in Gosper County, Nebraska.

At 89, he had been a cooperative observer since October 10, 1905. Over the years, he had won every award the Weather Service had to offer its unpaid observers—length of service emblems, the Holm Award, the Jefferson Award, letters of commendation from the Secretary of Commerce and Presidents.

National Weather Service Central Region Headquarters in Kansas City wanted very much to do something special for Stoll's anniversary. No one—ever before in history—had kept a non-stop record of the character of each of the more than 25,500 days that make up 70 years. His unique achievement called for a unique recognition.

The Edward H. Stoll Award, a length-of-service certificate, was the brainchild of Bernard E. Spittler, chief of Substation Management for Central Region Headquarters. Together, he and Central Region Director Charles G. Knudsen wrote to Weather Service Headquarters in Silver Spring, Md., proposing the special award.

But Stoll would not be the award's only recipient. Once established, it would be given annually to any volunteer who had completed 50 years or more of continuous service. Between five and ten individuals reach that milestone each year.

Weather Service Director Dr. George P. Cressman heartily endorsed the idea and started the request moving through channels. The award was approved by NOAA and sent on its way for Commerce Department approval. At first, there was some hesitancy about naming an award for a contemporary observer—other volunteer observer awards were named for weather heroes remote in time. Finally, all objections were overcome, and the Edward H. Stoll Award was born.

He heard about the new award when Spittler called to tell him what the Weather Service had done. Surprised and pleased, Stoll responded with characteristic aplomb.

United States
Department of Commerce

National Oceanic and Atmospheric Administration
National Weather Service

Edward H. Stoll Award

Presented to

Edward H Stoll

For serving 50 or more years as a cooperative weather observer

Issued *December 10, 1975*

Regional Director — *Director, National Weather Service*

The Edward H. Stoll Award, above, will be given to volunteer weather observers who complete 50 years of service. At right: Mr. Stoll with rain gage on his farm in Nebraska. He completed 70 years of observations on October 10, 1975.

"I noted the day," he said, "and I kind of wondered if the folks at Weather Service would take a special note of it. But then I thought, 'They've done so much for me already that maybe this time I'll just be getting a letter.' "

About the new award, Stoll said he felt "real good"—and thankful he's had his health all these years.

"It's a tragedy," he feels, "for anyone to come down to the end of life's journey having given no service to their God, their country, or their fellow man."

Stoll is a man who has lived by this philosophy. As to his 70 years of service, Stoll says anyone can do it—if they start young enough and if they have the patience to stick to it.

"There's a 13-year-old observer here in Nebraska right now," he said, "and she may beat my record yet—if she keeps at it."

Stoll was barely 19—he was born September 25, 1886—that October day in 1905 when a neighbor came bringing the official weather instruments to the Stoll place. He was moving away, he told Stoll, and added, "it's your job now."

The young Stoll had no way of knowing he'd be at it so long. Nor that he'd live all his life on the Nebraska farm he was brought to from Kansas in 1888, when he was only one-and-a-half years old.

The Great Plains of the late 1880's were still being settled by pioneer farmers, well aware that their success could depend on a knowledge of the climate.

Only a few scattered observers had kept an eye on the weather before 1870, but in 1869, when the "Golden Spike" united rail-

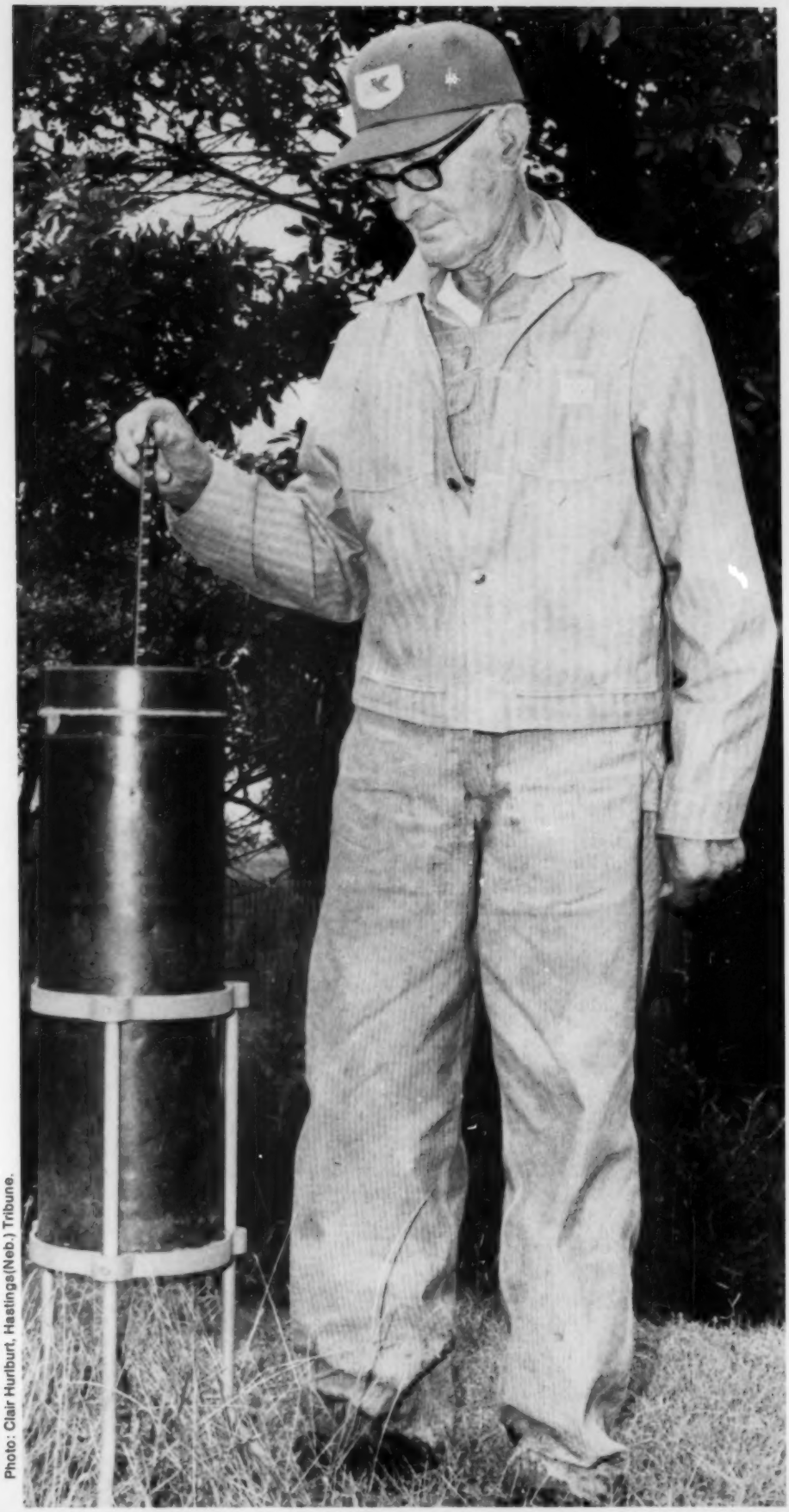


Photo: Clair Hurlburt, Hastings(Neb.) Tribune.

roads from coast to coast, transcontinental travel by rail became a reality. In the 1870's and '80's, the railroads promoted an organized network of weather observers to assure the safety of passengers and freight. Many of the early observers were railroad agents. Others were crop-oriented farmers.

Early observers frequently noted prairie fires and dense smoke in their reports. Lack of good roads made mailing the monthly reports difficult. There were other problems, too.

In December, 1890, William Waterman of Hay Spring, Neb., wrote, "Report is late this month on account of Indian scare. Too much confusion to get time to make report."

Edward Stoll was just four at the time. Fifteen years later, he began his own weather observations. The year before he began, 1904, the Kinkaid Act opened Nebraska's range land to homesteaders, and Nebraska was on its way to becoming part of the nation's breadbasket.

On the 320-acre Stoll farm, the main crops were wheat, corn, and milo—an early-growing, drought-resistant grain sorghum important for cattle feed. Through the years, each morning at 7 o'clock, Stoll recorded the 24-hour precipitation, the kind of day, the winds, storms and their duration, and anything unusual about the weather.

He recalls 1915 as the wettest year—36.64 inches of precipitation. The driest was 1934 with only 12.37 inches of moisture recorded. This was one of the Dust Bowl years.

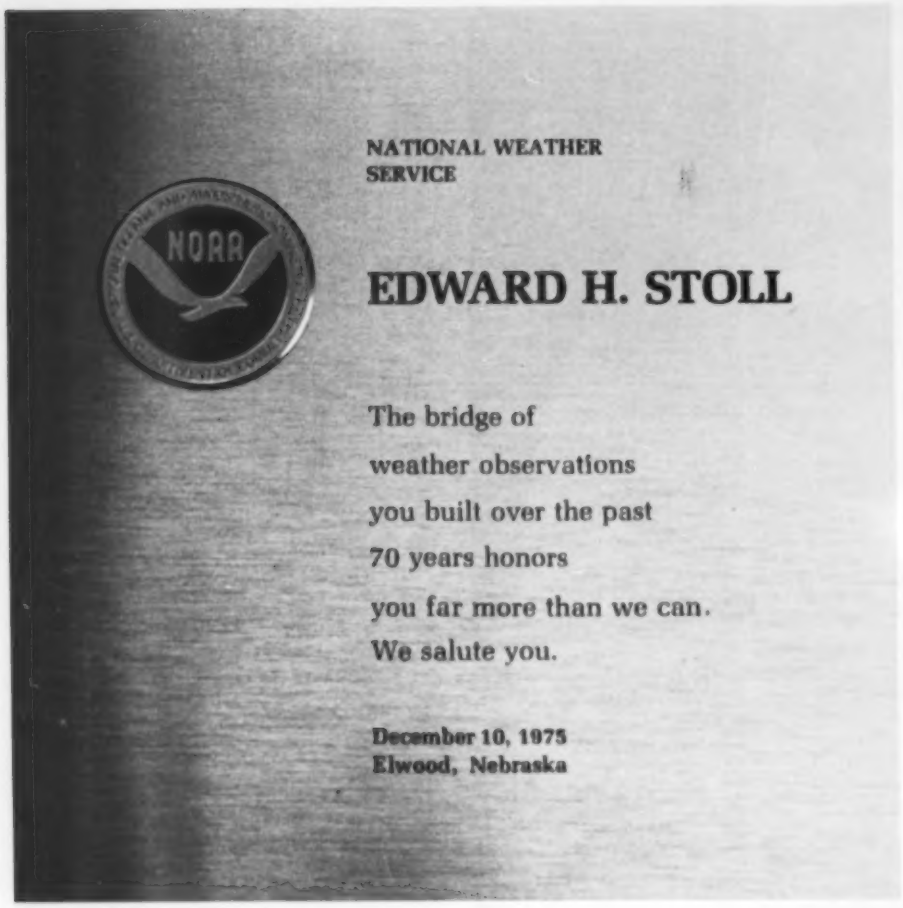
He noted the Republican Valley flood—May 31-June 1, 1935—that killed 101 persons. He noted a tornado that killed a neighbor. And a rainbow that shone one Thanksgiving Day.

But the storm most vivid in his memory is the November 18, 1948 blizzard.

Blizzards are expected occurrences in the Plains states. A blizzard combines winds of 35 miles per hour or more, falling and blowing snow, and temperatures of 20°F or lower. Nearly every year on the Great Plains, a storm classified as a blizzard occurs. Severe blizzards with windspeeds 45 miles per hour or more dense snowfall and temperatures below 10°F happen every few years. Stoll has recorded 22 such severe storms.

The Year of the Great Blizzards was 1888 when a January storm covered ten Midwestern states with great loss of life, and a March storm blanketed the Eastern Seaboard from Maryland to Maine, killing 400 persons, 200 of them in New York City alone. Stoll admits he doesn't remember these storms, but the November 18, 1948 storm was one of the most severe winter storms on record.

The 1948 storm covered northeast and east-central Colorado, the western two-thirds of Kansas, and most of central and northeastern Nebraska. Sixty to 80 mile per hour winds filled the air with blowing and drifting snow, reducing visibility over the area to near zero. Communities were isolated for days by drifts up to 20 feet high. The death toll was three persons in Kansas,



one in Colorado, and six in Nebraska. Property losses in the three states—much of it in livestock—ran into the millions.

"A very peculiar stationary storm," Stoll called it, adding that it struck Elwood around 3 a.m. but didn't reach Arapahoe, nine miles away, until later that afternoon.

Measuring precipitation during a blizzard presents its problems.

"I've walked a half-mile or more many times just to find a level field to measure the snow," Stoll said. He's measured more than a hundred feet of snow over the years.

As much as he's interested in the weather of the past, Stoll is just as interested in what's happening today. Now retired from active farming, he still lives on the home place, still records the weather each morning.

"This has been a peculiar year," he said in late 1975. "June 1975 was the wettest month in 70 years—11 inches of precipitation. We've had 25.08 inches of precipitation to date but it's still a dry year."

Stoll—who began his observations before anyone in the present-day National Weather Service was even born—is now the unchallenged dean of the Service's more than 13,000 cooperative observers who collectively record millions of observations each year.

Weather records, like fine wines, improve with age and form a fund of information, a data base, for comparisons and, in some cases, long-range forecasts. Once a month, the observers mail their records—kept on forms furnished by the Weather Service for the purpose—to NOAA's Environmental Data Service. At the EDS National Climatic Center in Asheville, North Carolina, the records are processed—punched on computer cards and stored—ready for instant retrieval when the need arises.

Many individuals in the program have compiled records for 30 or 40 years. Some station records have passed from father or mother to son or daughter, and then in turn to grandson or granddaughter, for decades of weather records from a single family. In some cases, companies or institutions have been hosts to official weather stations and have designated employes to keep the records.

The Stoll award will be given to individuals only, but the Weather Service has no volunteer who has completed a length of service approaching Stoll's 70-year record.

The Jefferson award is given each year for unusual and outstanding accomplishments in the field of meteorological observations. Jefferson, writer of the Declaration of Independence and third President of the United States, kept an almost continuous record of the weather from 1776 to 1816. Usually no more than five persons annually are chosen for the Jefferson award.

The Holm award is given each year for outstanding observer accomplishments. John Campanius Holm, a Lutheran minister, took the earliest known weather observations in the United States in 1644 and 1645 at Fort Christina, near what is now Wilmington, Del. About 30 persons a year are chosen for the Holm award.

Criteria for selecting the Jefferson and Holm award winners include complete, legible and accurate records extending over a long period of time, care of instruments, timeliness, observations recorded under hazardous conditions, unusual efforts to maintain continuity of the records during illnesses, absences or equipment failure, independent preparation or publication of climatological summaries, dissemination of weather information to the public through local news media, and enthusiasm for sharing one's knowledge with school groups and others. As a corollary, Jefferson and Holm winners are consistently held in high esteem by their communities.

The Jefferson and Holm awards were established in 1959. Stoll was among the first group of 25 volunteers to receive the newly created Holm award in 1960. At that time, he said:

"It has meant a lot to me during these years to be a weather observer, and the greatest satisfaction is to know that I have rendered some voluntary service to my country."

But his farm and the weather werent's the only boundaries of Stoll's life. After the loss of his wife, he raised his two children. Through most of his active years, he was an insurance agent. And a Sunday School teacher. And a member of the soil conservation and weed district boards in his community. He found time to speak before many organizations throughout Nebraska on his lifelong interests—the weather, and soil conservation practices.

In 1970, Stoll was named an Outstanding Citizen of the State of Nebraska by the South Platte United Chamber of Commerce. In October, 1970, an Edward H. Stoll Recognition Banquet was held in Arapahoe, Neb., where 200 of his fellow citizens paid tribute to his years of service as a weather observer and as a pioneer in soil conservation.

At the banquet, Stoll received a Weather Service Centennial Medal, a certificate from the American Meteorological Society for his contribution to the science of meteorology, a letter of appreciation from NOAA Administrator Dr. Robert M. White, a gold-plated rain gage—and was commissioned an Admiral of the Nebraska Navy.

In 1973, Stoll received the Jefferson award, the highest honor the National Weather Service could then bestow on him. He summed up his philosophy that every person owes some free service to his country by saying:

"Service is the rent you pay for the space you occupy as you go through life."

In 1975, Stoll became the first recipient of the National Weather Service's newest accolade for its volunteer weather observers—the Edward H. Stoll Award—fittingly named for a man who has practiced what he preached.

Fishing by satellite

Those Big Ones Won't Get Away Any More

BY BRIAN E. GORMAN

Ron Andriani has been fishing for albacore tuna for almost 10 of his 34 years. Like the more than 3500 other commercial tuna fishermen on California's coast, he spends most of the time aboard his 42 foot vessel, *Bandit*, not actually hauling in tuna, but searching for them.

It's not unusual for *Bandit* to steam for two or three days before hitting a school of albacore, and during that time, Andriani may travel more than 200 miles offshore, using three or four gallons of diesel fuel an hour. With the price of fuel edging up toward 40 cents a gallon, that steaming time can represent a sizeable chunk out of his profit. "We can spend $150 on fuel alone before we ever catch a fish," Andriani says.

All that may be changing. Since April of 1975 Larry Breaker, an oceanographer at the National Environmental Satellite Service in Redwood City, and Fred Jurick, a Sea Grant marine advisory agent at Humboldt State University in Eureka, have been working on a project involving some sophisticated satellite and computer hardware and some optimistic tuna and salmon fishermen —Ron Adriani among them—on the northern coast of California. The project consists of receiving infrared satellite imagery of the eastern Pacific and converting it into sea surface temperatures. The sea surface temperatures are then transferred as lines representing thermal fronts onto standard navigation charts for distribution to the fishermen.

The idea of transmitting to fishermen sea surface temperature data collected from remote platforms, while not new, has not previously been made routinely operational. In the summer of 1973, for example, a salmon project at Oregon State University, sponsored by the National Science Foundation, produced a series of temperature charts from infrared data collected aboard aircraft. But the aircraft flights were expensive and the coverage was limited by the range of the aircraft employed. Similar programs on tuna have been undertaken by the Inter-American Tropical Tuna Commission and the National Marine Fisheries Service.

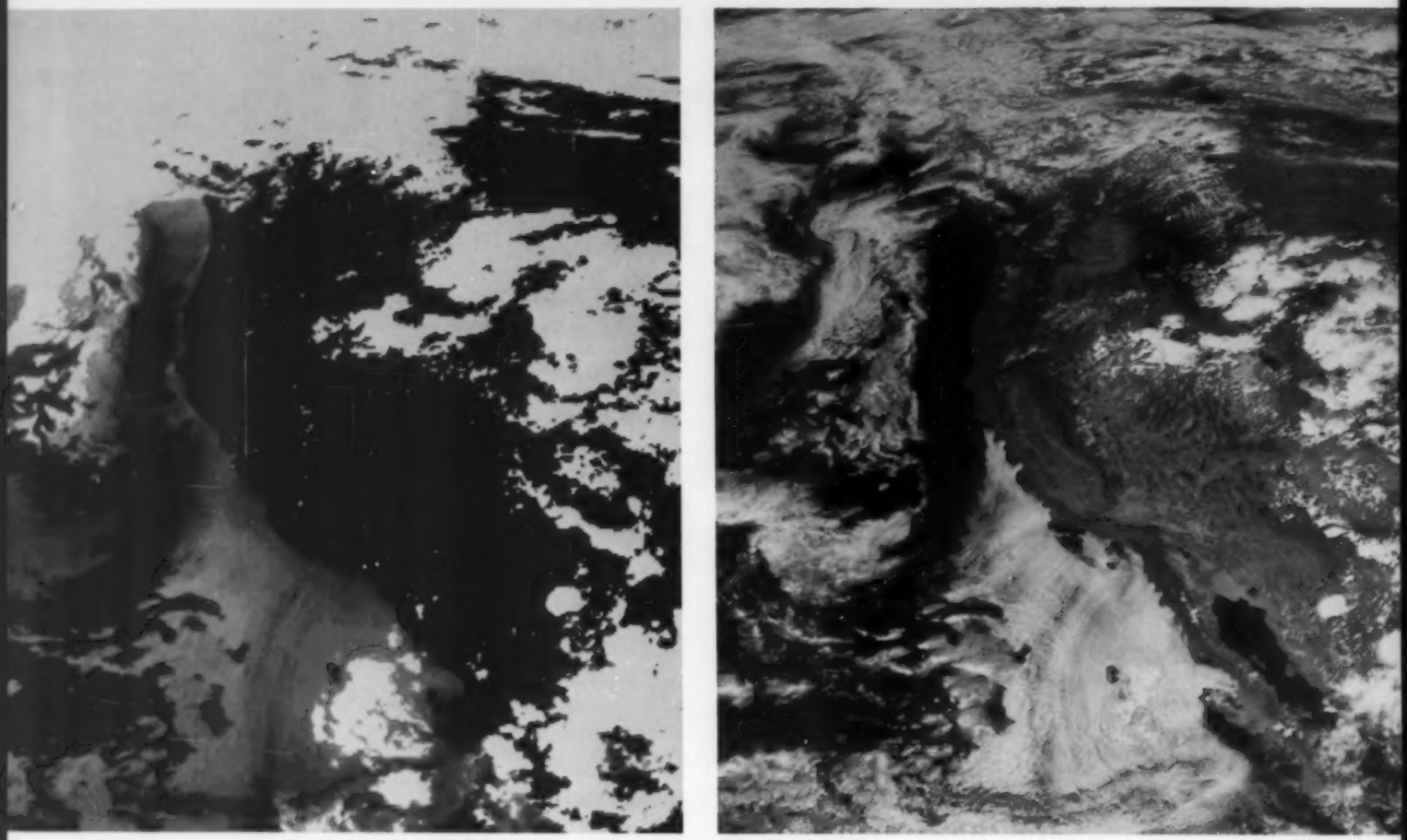
"What is new here," explains Breaker, one of the men who started up the project last year, "is the vast improvement in quality and coverage provided by the latest generation of environmental satellites now in operation. "And," he adds with emphasis, "the close cooperation NESS has had with Sea Grant Advisory Services in order to get the temperature data out to the fishermen."

Albacore fisherman Ron Adriani (l.) and Marine Advisory Agent Fred Jurick study navigation chart showing thermal fronts, in search for likely tuna fishing spots. Charts are produced cooperatively by National Environmental Satellite Service and Humboldt State University Sea Grant Advisory Services for northern California fishermen.

What does seawater temperature have to do with locating salmon and tunafish? Oceanographers and fisheries biologists have known for a long time that certain fish are very temperature-sensitive. Although temperature sensitivity is a complex phenomenon, it may play a role in helping such fish as coho salmon and albacore tuna locate areas of upwelling.

"Along the California coast," explains Breaker, "when strong winds blow up from the north and northwest, coastal surface water is moved offshore. It is replaced by colder, nutrient-rich bottom water." These upwelled bodies of water are known to be biologically productive regions. Almost immediately after they appear, the normally deep blue water turns a pale green, the result of huge blooms of plankton, the microscopic plants and animals that serve as the primary food source for all marine life. Larger and larger fish are drawn to the upwelling site until eventually salmon and tuna begin feeding on the bait-fish.

Albacore are known to prefer temperatures in the neighborhood of 58°-65° F. (14°-18°) and they tend to congregate on the warmer or seaward side of thermal fronts where their food supply may be located. Coho salmon, during the time they spend in the ocean, prefer temperatures



Infrared (l.) and visual satellite photos of Pacific coast. Many shades of gray in infrared photo show many water temperature differences detected by satellite. Enlargement of California coastal waters (facing page) has thermal fronts sketched in; these will be transferred to navigational charts for use by fishermen.

ranging from about 52° F. to 56° F. (11°-13°). Like the albacore, coho are often found concentrated near these thermal fronts —usually on the cooler or landward side— and for the same reason.

The problem, according to Jack Bottoms, Satellite Field Service Station Manager, is that the thermal fronts don't remain in one place for very long. "If they did," adds Bottoms, "the fishermen could simply keep going back to the same locations throughout the season. What we needed was a way to determine just where these fronts are, and a method of communicating that information to the fishermen as quickly as possible."

The first part of the problem really had already been solved. In November 1973, the third of a series of Improved TIROS Operational Satellites, the polar orbiting NOAA-3, was launched. Aboard NOAA-3 is a highly sophisticated electronic system that is sensitive to the infrared band. Special sensors look not at the visible portion of the light spectrum but at its invisible longer wave lengths. Since the amount of infrared emission indicates the temperature, the satellite can differentiate between warm and cool areas on the earth's surface.

In the fall a new ITOS is scheduled to be launched and is expected to take over the functions of NOAA-3. It will be known as NOAA-5.

"NOAA-3 is particularly well suited to reading the very complex differences in sea surface temperature, and we are looking forward to the increased capability of NOAA-5," says Bottoms. "Both have what we call a VHRR (Very High Resolution Radiometer) on board. The VHRR has a spatial resolution of about one kilometer and can transmit temperature information in 256 shades of gray." This means, he adds, that not only is the satellite image sensitive to the entire range of possible sea surface temperatures but that it can detect these differences even when they are less than one nautical mile apart.

The logistics of receiving and distributing the sea surface temperature data are fairly straightforward. Twice a day NOAA-3 passes over the California coast in its polar orbit. It beams a visual television and infrared transmission to the NESS Satellite Field Services Station at Redwood City. There the information is received and "enhanced."

The infrared enhancement is accomplished by using special computerized enhancement tables. Specific values are assigned to each bit of infrared temperature data in such a way that the temperature values are converted from numbers to various shades of gray. The result is a "photograph" that indicates changes in the sea surface temperatures as small as 1.0° F. The thermal fronts caused by upwelling bottom water show up clearly as irregular light gray-dark gray boundaries in the "photograph."

The satellite sensors do not realize that they are viewing part of a sphere, the curved surface of the earth. As a result, the initial enhanced imagery collected from NOAA-3 contains significant distortion which increases in either direction toward the horizon. To compensate for this distortion, the NESS office uses a new optical device called a Zoom Transfer Scope. In effect, the Zoom Transfer Scope stretches or "undistorts" the image. To make this information useful to the fishing fleet, the now undistorted locations of the thermal fronts are transferred to ordinary navigation charts and the charts, reduced in size for convenience, are sent to Fred Jurick.

"The special charts are the payoff item of the entire project," says Jurick. "Without them, the information is useless to the fishermen." Time now becomes the critical factor. Unless the charts can be gotten to the fishermen within a few days, the fleet may

be searching for albacore or salmon that are no longer where a chart says they are.

"To be honest," admits Jurick, "we originally had some problems in getting the information out. The only Zoom Transfer Scope available was at the Geological Survey office in Menlo Park. That meant a day's delay in driving down there and back again with the improved image. Then the charts had to be mailed to me in Eureka—another day or two delay. It could sometimes be almost a week between the time the satellite made its transmission and the time a fisherman actually saw the chart."

During the 1976 season, which runs from late spring through fall, things promise to be speeded up considerably. The NESS Field Service Station is acquiring its own Zoom Transfer Scope and Jurick is setting up a plan to speed actual delivery of the charts—a telecopier system along the coast.

"We are beginning to line up the equipment for our 'jungle phone,' " adds Jurick. "By using a chain of telecopiers, ports all along the California coast can receive the water temperature information within hours after it is produced. This will be virtually real-time data and should be a genuine breakthrough for the project."

Other difficulties with the satellite system are not so easily solved. Chief among them is the weather. For all its sophistication, the NOAA-3 VHRR cannot see through clouds. During periods of bad weather, when there is a cloud cover off the west coast, no usable infrared imagery is received. There may be a silver lining, however. Except during the periods of particularly heavy overcast, there are frequently scattered breaks in the cloud cover during the day.

But NOAA-3 makes its passes over California only twice a day. What if the breaks don't coincide with the satellite passes? "We have a back-up system," explains Breaker. "Next season we'll be using information from NOAA's GOES satellite." GOES—for Geostationary Operational Environmental Satelllte—was launched in February 1975 and is in orbit that places it constantly over the equator at about 115 degrees longitude. Although the infrared spatial resolution of GOES is inferior to that of NOAA-3—only about eight kilometers—it produces visual and infrared transmissions every half-hour. "By piecing together information from several transmissions from the geostationary satellite when cloud cover is intermittent," Breaker claims, "and by combining it with more precise imagery from NOAA-3—and then NOAA-5—we ought to be able to come up with enough usable data to construct fairly accurate sea surface temperature charts even when conditions are less than ideal."

The other major problem confronting the NESS/Sea Grant project is the rapidity with which the sea surface temperatures can change. During good weather, even with a cloud cover present, thermal fronts can remain stationary for several days, making it unnecessary to update charts more than once a week or so. But during a storm, strong winds, which cause the upwelling in the first place, may completely change the location and configuration of the thermal fronts.

"Fortunately," explains Jurick, "we have two things going for us, both a function of the weather. During a real blow, when the temperature gradients are actually shifting, the fishermen aren't likely to go out of port. Secondly, right after a storm, just when we need the information most, the weather is generally ideal for taking satellite pictures. There usually is no cloud cover. The new thermal fronts are in place and show up well.

"And," he adds, "most of the fishermen are still in port where they can be conveniently contacted with our new set of charts."

What will all this information do for the commercial albacore and salmon fishermen? Fred Jurick explains. "There are three ways a fisherman can increase his profits. He can get more money for his product. He can reduce his cost of catching a given volume of fish; in other words, reduce his overhead. And he can catch more fish. We feel that the NESS/Marine Advisory Service collaboration can make a serious contribution to two of these goals by enabling fishermen to catch more fish and catch them more cheaply by reducing the fuel and searching time for each trip."

An additional benefit of the new satellite infrared imagery is that the information encourages better management of the fishery and more economical use of the fleet. Traditionally, vessels have tended to concentrate their efforts on two or three areas that have proven to be good fishing grounds during the preceding week or so. Since more than a half-dozen thermal fronts stretching over 500 miles may show up on a given satellite transmission, the result of the new technique should be to spread out the fleet. This will allow fish to be harvested from areas that might otherwise have been overlooked and should reduce competition among vessels for a particular stock.

"Not only are we making better use of a natural resource, the salmon and tuna," suggests Stan Ludwig, head of the Marine Advisory Service at Humboldt State, "we are also making better use of one of our own man-made resources, the NOAA Satellite system. The satellites are up there sending their signals to earth at regular intervals. With no additional manpower and very little additional cost we at the advisory service, with the help of NESS, have made more efficient use of those signals. It's that simple."

If you ask Ron Andriani how well the satellite information has worked so far, he'll answer in one word: great.

"In spite of the bad weather last season," he says, "every time I used one of those charts, the fish were right where they were supposed to be. You can't ask for anything better than that."

The latest on the lakes

Great Lakes Water Levels: An Update

BY JANE E. O'DELL

"This is NOAA Weather Radio, Station KEC 63, Detroit, Michigan, broadcasting on an assigned frequency of 162.55 Megahertz. A lakeshore warning is in effect for the Lake Erie area west of Vermilion, Ohio, including the Michigan shoreline, portions of Lake St. Clair and Saginaw Bay. Persons in affected areas should take proper precautions and be alert for high water and damaging waves."

Great Lakes shoreline residents assumed that they would not be hearing such dreaded announcements as often in 1975 as in previous years. They thought at least the frequency of this message would decline after the high water period of 1972-73.

What has happened since then? A number of noteworthy events have occurred:

In general, lake levels have not gone down as much as expected.

Basin-wide precipitation was above normal for the remainder of 1973; below in 1974 but will be above again in 1975.

About 174 miles of temporary crib dikes have been erected by, or with Corps of Engineers assistance in many flood-prone areas.

The frequency of severe storms, after two serious ones in 1973 (April 9th and June 17th) and four in a 30-day period in March-April 1974, was below normal until later August of 1975 when an earlier-than usual 'nor'easter' pounded dikes and shorelines followed by another on October 17th and 18th that did the same.

A number of Lake Survey Center gages have been telemetered which assists the National Weather Service Forecast Office in the issuance of warnings and the Corps of Engineers in its responsibility of flow regulation.

Two Corps of Engineers-initiated plans, one in existence and the other in planning, have helped, or will help in varying degrees to alleviate the high water situation, particularly for the lower lakes, including Lake Erie.

Several other Federal agencies have improved their programs to assist persons in damage-susceptible areas.

Lakes Superior and Ontario are now near their long term averages. However, the others, especially St. Clair and Erie, continue well above their long term means. In 1973, Lakes St. Clair and Erie set new highs for every month, except November and December, which had been set the year before, and peaked in June at record 4.53 and 4.91 feet above low water datum. Then, for the third straight year, new high records were made on Lake St. Clair for two consecutive months—January and February—and then again in May 1974. After 1974 the levels of these lakes stayed close to but below their record highs. Lake Ontario followed suit by breaking a record for May 1973, but after high levels in 1974, proceeded to go down in 1975, coming close to its averages. The outflows from Lake Ontario have been controlled since the St. Lawrence Seaway was completed in 1958. Control of outflows, of course, does provide some means of regulating lake levels under normal or near-normal conditions. During the first years of the Seaway's operation authorities responsible for adjusting flows dealt only with low water conditions, thus had no experience concerning high water on the new system. Above-normal levels on Lake Ontario posed problems which had not previously been encountered. These dif-

Photo: Detroit News

Fierce waves on Great Lakes can reach more than 12 feet during storms (above). At left, water level gage expert Edward Gurche of Lake Survey Center (top) checks equipment in telemetered guage site (left, below). Robert Goodnough, LSC, receives telemetered gage data in LSC offices, Detroit.

ficulties were compounded in 1972 when the remnants of Hurricane Agnes dumped unprecedented amounts of water on Lake Ontario and Lake Erie, which enters into and affects, Ontario. This plus related factors caused extreme high water on Ontario in 1973 and the first half of 1974. Severe flooding and erosion were common. Problems were accentuated by the fact that Lake Ontario normally reaches its annual high at a time when the threat of spring storms still exists. Deviations from the regulation plan and careful analyses and control have lowered Ontario's water to the safe level. From late 1974 through 1975 that lake has been at or near its long-term average. Although Lakes Michigan and Huron have continued to stay above long-term averages they are safely below their records but still, as noted, high enough to cause problems during storms.

Lake levels followed the amount of precipitation received on the Great Lakes Basin with a normal and expected time lag. In 1973 when levels were at record high, precipitation over the entire basin was seven percent over the average. In 1974, with slightly lower lake levels, precipitation was actually eight percent below normal; and in 1975, using preliminary figures for September and October and assuming average rain and snow rates in November and December, precipitation is expected to be about five percent above its average at 33.17 inches. Until August, 1975 was not an extremely wet year, although a little above normal precipitation had fallen. Then, in August Lake Michigan got 114% above normal rainfall (6.71 inches compared to an August average of 3.14); Lake Erie (including Lake St. Clair) received 140% above normal rainfall (7.32 inches—the average is 3.05 inches); Lake Huron 48% above normal and Lake Ontario 34% above normal. Only Lake Superior was below its August normal with 30% less than average received. So for the seventh year in the last 10 the Great Lakes basin will receive above normal precipitation.

What has been done to help those who live on the lakes from the ill effects of all this water? Dikes have been constructed at a total of 199 locations in the States of New York, Ohio, Michigan and Wisconsin and protect such areas as Olcott and Irondequoit Bay, New York; Conneaut and Ashtabula, Ohio: Gibratar and Monroe, Michigan, and Green Bay, Wisconsin. These unprotected shores in critical areas received extensive damage in 1972 and 1973. However, since then most of these susceptible areas have had study dikes erected by the Corps of Engineers or under a 'Help Yourself Program' where dikes were built to Corps designs by local citizens. They provide the best short-term defense against flooding. It has been estimated that the over-25 million dollars spent on diking has prevented an estimated 120 million dollars worth of property damage. The dikes are temporary and will come down eventually. However, until considerable expanse of beach is exposed by lower levels they must remain in place. Since the fall of 1974 was a relatively quiet period for serious storms, citizens whose property had been diked frequently said, "levels are receding, so let's take the dikes down." Then storms hit earlier than usual in 1975, at the end of August and on October 17-18. Without the protection, the damage could have been serious. After those storms property owners were glad the dikes were still standing.

Storms in the spring of 1974 also tested the diking system. During one storm which occurred on April 8-9, 1974, winds gusted at over 50 miles an hour and the water levels reached the same height as on April 1973 when flooding had occurred on the unprotected shores of Lake Erie and St. Clair. However, this time where dikes had been constructed the wind-driven storm caused

Photo: Corps of Engineers

Although precipitation was slightly lower in 1974 than 1973, water levels on the Great Lakes remained unexpectedly high during both 1974 and 1975, and homes near the shore could not escape the fury of high water and pounding waves.

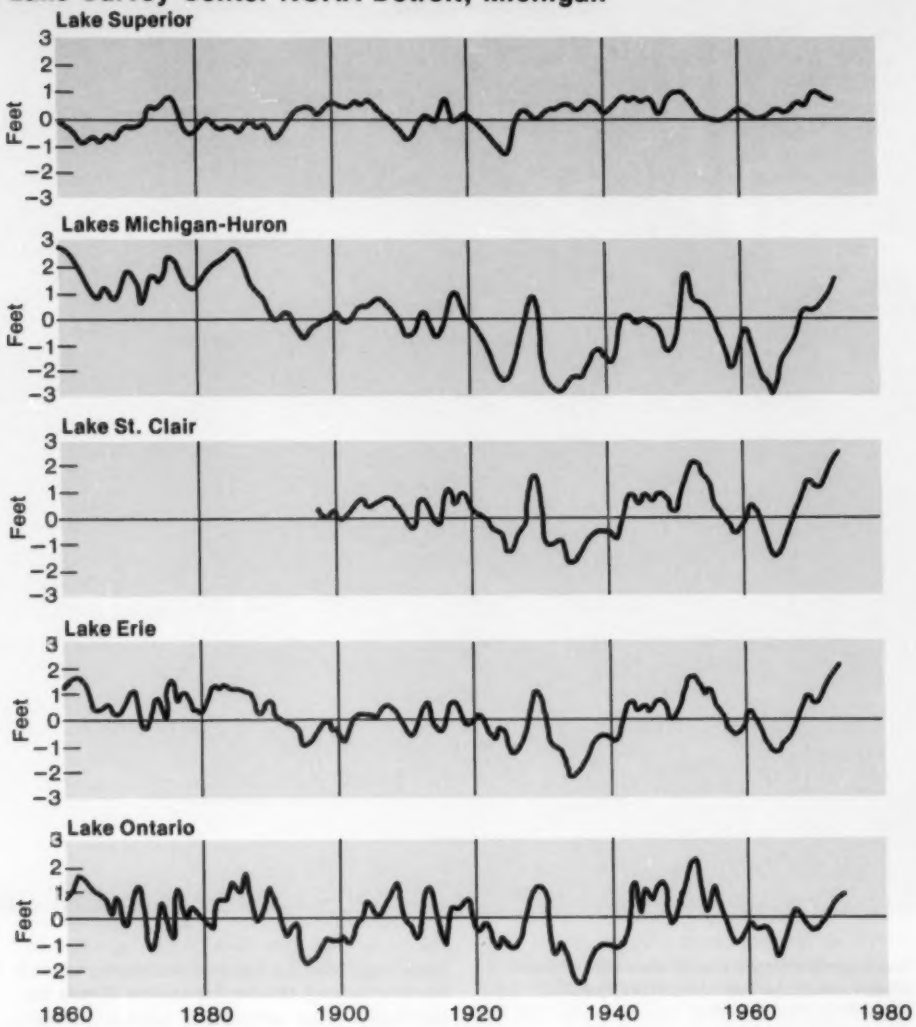
only minor seepage in some low-lying areas. In two spots, Stony Point and Swan Beach, Michigan, the foundations of two small diking sections, measuring 200 feet and 60 feet, were undermined and were breached. However, the portion at Stony Point was on relatively high ground, so no flooding occurred. Immediate action by the Corps of Engineers personnel in rapidly mending that portion at Swan Beach reduced the possibility of damage there.

These dikes were constructed under the Corps of Engineers' Operations Foresight, created under Public Law 99, to protect shorelines from flooding. The Corps of Engineers Detroit District has been especially active in the program, as were the Chicago and the Buffalo Districts of the Corps. Two reasons prevented the erection of dikes in some areas that should have had them: (1) there just was not enough beach on which to put them up and (2) to put it bluntly, the value of the property did not justify protection. Those persons whose property has not been diked are still evacuated during storms and the early warning set up by NOAA's National Weather Service, the Office of Emergency Preparedness and other agencies are essential.

Home and cottage building has increased rapidly along Great Lakes shorelines since the last high water period in 1952. Many were built too close to the edge of highly-erodable cliffs and bluffs. Dikes cannot be built to protect erosion-prone shorelines. Public Law 99 provides for protection from flooding *only*. Much informational material regarding protection of shoreline property, instructing homeowners in these areas of what they can do to protect their property from erosion has been prepared by various agencies and distributed to concerned citizens. One example is a pamphlet called "Help Yourself." Issued by the Corps of Engineers, it describes the different types of economical systems which have been used with success in the Great Lakes, such as stone and gabion revetments, the types of materials used, and how they are constructed. Also, together with the tried and true methods to prevent erosion, it has been a time for experimentation. The State of Michigan for one has set up 15 experimental projects designed to prevent erosion. Areas include portions of Lake Michigan, Huron, and Superior. Since most home owners can afford less than $100 per foot of frontage for protection inexpensive means were taken as the primary goal. Two ideas derived from this project have generated great interest. One was to fill large flexible polyethylene tubes with lake sand that when finished looked like rolled-up carpeting, lying on the shore's edge. The compact sand is as dense as stones and helps absorb and break the energy of the waves, preventing the waves' full force from reaching the cliffs. The technique, relatively inexpensive, leaves free access to the lake without destroying the natural beauty of the shoreline. When the tubes are no longer necessary they will be bulldozed open and the sand used to reconstruct new beaches. The second is to dump large quantities of stones and rocks where these materials are common along shorelines and then covering them with asphalt, which acts as an adhesive. Both look promising.

Authorities agree that of all the storm systems that rake the Great Lakes each year it is the 'nor'easter' that is most feared by U.S. shoreline residents. The most susceptible areas are western Lake Erie, Lake St. Clair, Saginaw Bay and Green Bay. Meteorologist-in-charge, Charles R. "Bob" Snyder of the National Weather Service Forecast Office in Detroit reports that, "the key to our advanced detection of the northeast storm is a stalled, or slowly moving low pressure

Lake Survey Center NOAA Detroit, Michigan



Compiled from Lake Survey Center records, graph above shows variations in lake levels from long-term averages since collection of the data began in 1860; the 1970's have been years of high water levels on all the Great Lakes.

Great Lakes Precipitation (in inches) 1960–1975*

	Actual	Departure From Average	Percent Difference
1960	31.73	+0.17	....
1961	31.27	−0.29	−1
1962	28.51	−3.05	−10
1963	26.01	−5.55	−18
1964	31.27	−0.29	−1
1965	35.57	+4.01	+13
1966	30.85	−0.71	−2
1967	33.35	+1.79	+6
1968	35.82	+4.26	+14
1969	31.78	+0.22	+1
1970	34.25	+2.69	+9
1971	31.43	−0.13	....
1972	35.98	+4.42	+14
1973	33.87	+2.31	+7
1974	28.94	−2.62	−8
1975	33.17*	+1.61*	+5

***'75 figures use preliminary data for September and October and assume normal precipitation for November and December.**

NOTE: Figures are rounded off %'s

center with rapidly falling barometric pressures that is located over eastern Kentucky." He continued, saying, "most systems move fairly rapidly across the lakes so when we see a 'low' like that,—possibly stalled by a high pressure system east of there,—we are especially alert." When this situation exists it is like a chain collision on the freeway. Snyder concluded, "with the 'low' stopped it can be intensified by cold air joining it from the north or additional moisture from the south—and before you know it we are saying, 'A lakeshore warning is now in effect for ——." Interestingly, when a 'nor'-easter' is pummeling the Great Lakes, torrential rains frequently fall in Appalachia and usually cause flooding.

On October 17, 1975, at 6:40 a.m. Eastern Standard Time, as the sky in the east began to lighten, the Cleveland Weather Forecast Office started issuing a warning that potential flooding was possible on Lake Erie's western shore as suspicious conditions began to appear. Then, at 3:00 p.m. an official lakeshore warning broadcast for Vermilion to the Michigan shoreline began. The northeasterly winds had began to blow and would continue for two days, becoming stronger and eventually gusting to 55 miles per hour before the storm ended. Waves of up to 10 feet punished the shoreline, causing some erosion and flooding. The Corps of Engineers dikes and the help-yourself dikes took a severe beating but held. Waters from the Huron and Sandusky Rivers backed up five miles upstream from Lake Erie. Then, the winds lessened and at 4:00 p.m. on October 18th all became calm again, the warning was cancelled and most shoreline residents breathed a sigh of relief. That storm and the one which arrived the last weekend in August were different in one respect. This time shoreline residents were ready for them as they were in '74, little property damage occurred and evacuations in most places were unnecessary. In November 1972, the situation had been serious—the National Weather Service had issued a timely warning well in advance and a large scale evacuation followed, preventing loss of lives; however, the property damage mounted into the millions.

Since 1974, eight Lake Survey Center's water level gages have had telemetering systems installed and data now can be received instantaneously. Real time water level data can be received simply by dialing a phone number. When the equipment in the gage house is activated by telephone the receiver is placed on a special cradle and levels are printed out on a connecting teletype machine. There are three telemetered gages on Lake Superior, located at Duluth, Minnesota, Marquette and Port Iroquois, Michigan; one on Lake Huron at Harbor Beach, Michigan; one on Lake St. Clair at St. Clair Shores; one on Lake Erie at Cleveland, Ohio; and two on Lake Ontario at Rochester and Oswego, New York. The telemetered gages are used for forecasting the lake levels by the Corps of Engineers; and those on Lake Superior are used in regulating the outflow of that lake and those on Lake On-

Photo: Detroit News

One break in a private seawall allows the energy-packed waves to attack sandy and clay cliffs, undermining foundations.

tario for the regulation of its outflows. And the National Weather Service, of course, can query any of the telemetered gages when rough weather is approaching. Before the Lake Survey Center installed the telemetering system in 1974-75, field personnel called gage observers had to send the data in by mail from those selected gages. It could take a week to arrive.

In addition, the Lake Survey Center has installed battery operated Telemark gages for the U.S. Coast Guard at the LSC gage sites in Toledo, Ohio and Gibratar, Michigan, which are similar to the telemetering system used by the Center. The Coast Guard uses the data for navigational purposes; however, the National Weather Service receives water level data from the Coast Guard. Also, since June 1973, the police department at Gibratar, Michigan, on Lake Erie's western shore has been routinely connected to the LSC water level gage station there. The police there monitor the water level data continuously and NWS broadcasts for potential flood conditions so they can alert the citizens quickly if conditions warrant. In 1973-74, before the dikes were constructed around the town, evacuation of the citizens was necessary since the city is in a low-lying area and is laced with canals.

Of the five Great Lakes the outflows from two, Superior and Ontario, are controlled and the outflows from the other three; Michigan, Huron and Erie, are not. The International Joint Commission regulates Lake Superior through its International Lake Superior Board of Control and Lake Ontario through its International St. Lawrence Board of Control and receives technical support from the Corps of Engineers, Lake Survey Center and others. The International Joint Commission (IJC) is made up of high-ranking United States and Canadian representatives under which a variety of boards and committees operate. Since the Great Lakes are shared by both countries international cooperation is essential for the proper management of these valuable waters. A recent Summary Report by the IJC's International Great Lakes Levels Board titled "Regulation of Great Lakes Levels" presented a plan designed to balance the water levels in Lake Superior and Lakes Michigan-Huron. In part, the report states, "When Superior is high, water can be released. When Michigan-Huron levels are high, water can be retained in Lake Superior." The outflows of Lake Superior since 1921 and Lake Ontario since 1958 have been regulated by control structures in the St. Marys and the St. Lawrence Rivers respectively. The subjects of lake levels has been under study for a number of years. The aim is to reduce the frequency of damaging high and low periods. To date studies have indicated that total regulation of all lakes is economically not feasible. Lakes Superior and Ontario each have their own special regulation plan. The International Great Lakes Levels Board under the IJC is responsible for the development of such plans. One plan considers increasing the flow out of Lake Erie. This would be possible by building a controlled diversion through Squaw Island in the Niagara River. It would require cutting a channel 35 feet wide and approximately 1,500 feet long through the island. A 35-foot tainter gage would control flows. The plan, if effected, would increase the flow out of Erie by an estimated 8,000 cubic feet per second (cfs). Although small when compared to Niagara's average flow of 202,000 cfs the project would nonetheless provide some benefits.

Two other Federal agencies helped directly during these years. They are the Small Business Administration and the Department of Housing and Urban Development. The SBA provide low-interest loans for flood-damaged property, under certain circumstances. HUD subsidized flood insurance

through private insurance companies for endangered communities. In 1974 this program was expanded, so that larger amounts could be obtained if shoreline property was damaged.

High water plus storms cause two separate and distinct problems—flooding and erosion. Hardest hit by flooding are low-lying areas, such as western Lake Erie, Lake St. Clair and Lake Huron's Saginaw Bay and Green Bay, Wisconsin on Lake Michigand and parts of Lake Ontario. Winds cause storm surges and drive waves inland causing flooding. Storm winds, that is those from a fairly constant direction over an extended period of time, actually tilt the lake's surface, forcing water up the beach at the lake's downwind end. Because three of the lakes, Erie, Ontario and Superior, configurations are roughly on a northeasterly-southwesterly alignment, storms from that direction usually do the most damage. Although the other lakes can tilt, Lake Erie is the most seriously affected by this phenomenon since it is relatively shallow at its western end, and that shore's only a few feet above the water for a considerable distance inland.

Erosion, the other problem, has affected all Great Lakes shorelines to varying degrees. During low water situations, storm driven waves expend their energy on beaches. When high water conditions exist there are no beaches and the waves attack the bases of cliffs and bluffs, which are composed mostly of highly-erodable sandy and clay type materials. On Easter Sunday 1974 in Stickney Ridge which is located on Lake Michigan south of Grand Haven, Michigan, one cottage valued at over $10,000 took the fatal plunge. All it took was one break in the private seawall during a spring storm and the nine-year fight to save the cottage ended abruptly. The waves easily removed the soft type material from the bank's toe and gravity did the rest. In the State of Michigan alone, it was reported that in the past few years at least 800 homes were in jeopardy from erosion. Of those erosion-threatened homes, over a dozen have fallen into the lakes.

Flooding and erosion are caused by a combination of factors, primarily by winds and high waters. High lake levels in turn are caused by an over-abundance of rain and snow. The Great Lakes are a natural reservoir. Add more water than its outflow rivers can handle: the water level rises or—when 'inflow' exceeds "outflow", lake levels go up. Since 1965, precipitation on the Great Lakes has been above average except for the three years—1966, 1971 and 1974. The average annual basin-wide precipitation from 1900 to 1973 was 31.61 inches. When an inch of rain on one acre equals 27,000 gallons of water it's not difficult to see that over 31 inches on the 300,000 square-mile Great Lakes basin equals a tremendous amount of water.

Where does all this water go? First it recharges the ground supply, unless ground-water levels are high as they are now, then some of it is used up by plants (except during the nongrowing season) then it runs off into the lakes where part of it is evaporated, and lastly it goes out through the lakes' outflow rivers. These are the St. Marys, Detroit, St. Clair, Niagara and St. Lawrence Rivers. During the present crisis the outlet rivers have been discharging maximum flows which are about two to three times their minimum flows. This has not relieved the situation substantially, since, according to reliable estimates, it will take from 15 months to three years for the lakes to return to their average levels only after they start receiving normal precipitation. Ironically the rivers' capacities helped during low periods. In 1964-65 they helped to keep the water levels higher by restricting flows. Lake levels are also affected by evaporation. If it were not for that factor in the hydrological cycle another river the size of the St. Lawrence River, which averages about 240,000 cubic feet of water per second, would be needed to maintain normal lake levels. During high precipitation years when maximum evaporation is desirable it is usually below normal and the opposite is true during low precipitation years.

The rise and fall of Great Lakes water levels is not new. As early as the 17th century trappers and others noticed the fluctuation in the lake levels and attributed this phenomenon to solar and lunar tides. They thought as the oceans were affected, so the Great Lakes would be similarly affected. Although the Great Lakes have tides, they are small and are usually obscured by wind effect. Now those closely involved know that the levels are determined mainly by the effects of precipitation and evaporation.

Lake Survey Center is the NOAA agency that began keeping those records in 1860. Since then a network of gages has been operated and maintained on the Great Lakes by the LSC's Water Levels Branch. Today there are over 50 gages used by technicians who collect the data for chartmaking and navigational purposes, as well as for various important engineering and research studies being carried out on or near the Lakes' coastlines. And, as noted, NOAA's National Weather Service uses the data in its Lakeshore Warning Program.

Some feel that shipping concerns and hydroelectric plants benefit the most during high levels. This is true; however, when levels are extremely high as at present, they cannot always take maximum advantage of the situation. The average freighter can carry an extra 100 tons of cargo for each additional inch of water and hydroelectric plants need not worry about their supplies running out as happened in 1964-65. But the amount of cargo a ship can carry is controlled by other conditions and regulations, and power plants can use just so much water in making electricity. Extra water that cannot be put through the turbines because of upstream conditions has to be spilled. However, high levees have unexpectedly helped in other ways. Channel dredging in a number of areas was not needed as often as it would have been if the waters were lower. This has given those responsible for dredging the time to find disposal areas or construct such areas because dredged material is frequently polluted and by law cannot be dumped in open water areas as was the previous practice. Lake Erie which has had problems because of industrial pollution in recent years is cleaner now than before. Increased inflow from the upper lakes has had a flushing action. Lake Survey water level gage technicians on their regular inspection trips in 1975 reported that previously closed bathing beaches were open and residents commented on better fishing conditions.

The last few years have been a period of disillusionment and frustration for those living along the shores of the Great Lakes. Since 1973, shoreline property owners have put up a brave fight and in more cases than not have won their war with flooding or erosion. Many have decorated the wood dikes and one family drew Walt Disney-type characters on dikes fronting their property, giving their part of the shoreline a carnival look. All look forward to the time when the dikes—christened by some "The Great Wall of China"—can be removed and the lakes return to normal levels. It all depends on the type of weather the Great Lakes area receives over the next few months and years. Those living in erosion-prone areas who have not lost their homes or cottages have paid dearly for necessary protection.

Two free publications are of particular value to persons concerned with lake levels. The "Monthly Bulletin of Lake Levels" which has been printed and distributed by the Corps of Engineers since November of 1975 shows Lake Survey Center furnished highs and lows of record, long-term averages and present levels. A Corps-prepared six-month forecast on the Bulletin shows what is expected. Lake Survey's "Hydrograph" gives a historical look at levels from 1860 to the present.

Will the lake levels ever go back down to normal? The answer, of course is, yes. The real question is when? With average precipitation they will recede slowly; with well-below rain and snow they'll go down a little faster and, unfortunately with above normal precipitation they will stay as high, or even go higher. The Great Lakes are an extremely large and immensely complicated hydraulic system. Experts are quick to agree that man's effort in the face of rampaging natural conditions is no match. So while some adjustments to the system can be modestly beneficial the eventual alleviation of the present problem rests in the rather fickle hands of Mother Nature. What she has in store for the Great Lakes in the way of weather will be the determining factor. In the meantime, concerned NOAA units and other agencies have made, and will continue to make, every effort to soften the blow delivered by storm winds over high lake levels.

Acknowledgement:
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NOAA predictions and a Great Lakes challenge:

Beat The Seaway Freeze

BY JOAN VANDIVER FRISCH

When the French explorer Jacques Cartier pursued the mythical Northwest Passage in 1535, he was turned back by the St. Lawrence River's Lachine Rapids near Montreal, Quebec. His was perhaps the first disappointment in the difficult 250-year-long struggle to transform the great river into a continuous waterway from the Great Lakes and their connecting channels—a total of some 9,500 square miles of waterway—serving the industrial and agricultural heartland of North America. This continental core, extending over 1,285,000 square miles, encompasses the North-Central region of the United States, parts of four Canadian provinces, and sustains a population of over 60 million people.

Ocean vessels enter the inland waterway through the Gulf of St. Lawrence, sailing a further 700 miles westward to the mouth of the river at Father Point. The Seaway itself begins at Montreal, 340 miles west of the river's terminus and more than 1,000 miles from the Atlantic Ocean. The river level at the Seaway entrance is 20 feet above sea level, having risen gradually over more than 300 miles.

From Montreal to Lake Ontario, the vessel travels 182 miles, rising more than 225 feet with the aid of seven locks. Farther on, access to the downstream end of Lake Erie is barred by Niagara Falls. The Welland Canal, carved through 27 miles of the Canadian mainland and opened in 1932, provides inter-lake passage, lifting vessels some 326 feet to Lake Erie. A tightly grouped series of seven lift locks in an eight mile section overcomes the Niagara Falls obstacle. Lakes Erie, Huron, Michigan, and Superior, together with their connecting channels (the Detroit River, Lake St. Clair, the St. Clair River, and the St. Mary's River), and the locks at Sault Ste. Marie form the rest of the waterway. Once the ship has reached Lake Superior, it has climbed more than 600 feet or roughly the equivalent of a 60-story building.

The Seaway is a testimonial to man's triumph over nature's barriers—nine months a year.

But if the rapids have been conquered, the northland weather has not. The winter gifts of ice, poor visibility, and weather of legendary inclemency force Seaway operations to a frozen, foggy halt for three months or more out of every year.

Photos: St. Lawrence Seaway Development Corp.

Freighter transits seaway in winter (above) while tug acts as icebreaker (opposite page).

Commercial shipping activity into the Great Lakes normally ceases in mid-December because of extensive ice cover on the St. Lawrence River. Ocean vessels must vacate the Seaway system before an arbitrary closing date or face the prospect of being entombed for three and a half cold, unproductive months.

Two-to-three-month advance freezeup predictions of the upper St. Lawrence River could provide shippers the necessary lead time to schedule vessels through the Great Lakes until ice prevents normal navigation beyond the international locks at Massena, New York.

Scientists at NOAA's Environmental Research Laboratories were asked to work on solving the freezeup prediction problem. After studying records of past closing dates and the criteria used to establish the mid-December closing date annually, the researchers decided inadequate attention had been given to annual and seasonal weather variations. They found that records show freezeups vary by as much as three weeks from year to year.

Miscalculations of the December closing date can mean losses totaling nearly one million dollars a day to the combined interests of shipping, the Great Lakes region, and the St. Lawrence Seaway Development Corporation, which operates the U.S. portion of the waterway for the Department of Transportation.

Failure to close at the appropriate time can have serious consequences. Ice builds up on almost all exposed lock surfaces. When the gates of a lock are opened, ice floes are pushed into the lock chamber, inhibiting operations. Ice jams in the waterway's connecting channels can cut power production, affecting the way lake levels are regulated, and decreasing lake discharge capacities.

If the ice jam occurs downstream from a hydro-electric powerplant, higher failwater levels reduce production, and the plant itself can flood. Flood discharge structures reduce power production. Ice jams upstream from a hydroelectric power plant can impede water flow, reducing the water available to operate the turbines. Diversion of water around locks for flushing ice requires sizeable flows, reducing discharge available for power generation.

Premature closing, on the other hand, can trim revenues by hundreds of thousands of dollars per day for shippers and the Great Lakes community in general.

To help solve the problem, NOAA scientists at the Great Lakes Environmental Research Laboratory in Ann Arbor, Michigan, formulated a method for making advance predictions of the December freezeup and subsequent closing date. The technique uses mathematical equations developed by Dr. Frank H. Quinn and his GLERL colleagues in Ann Arbor, Michigan. The equations make it possible to base a freezeup prediction on only two quantities—the current water temperature at the head of the St. Lawrence River at Kingston, Ontario, and the predicted December flow rate and amount of heat lost in the river's 100-mile journey between Kingston and Massena, New York.

After the GLERL scientists tested the theory for three years using real weather data, they made the information available to an operational arm of NOAA in the area —the National Weather Service Forecast Office in Buffalo, New York. Using the equations, river temperature data, and predicted heat losses, James Smith, the meteorologist-in-charge, prepared predictions of the freezeup data and issued them for the first time this fall on the first and 15th of October, November, and December. The predictions were made available to the St. Lawrence Seaway Development Corporation for distribution to shipping interests in the United States and around the world, to the Corps of Engineers in Detroit, Michigan, and to U.S. Coast Guard Stations and the Toronto Weather Service Office via the Great Lakes teletype circuit.

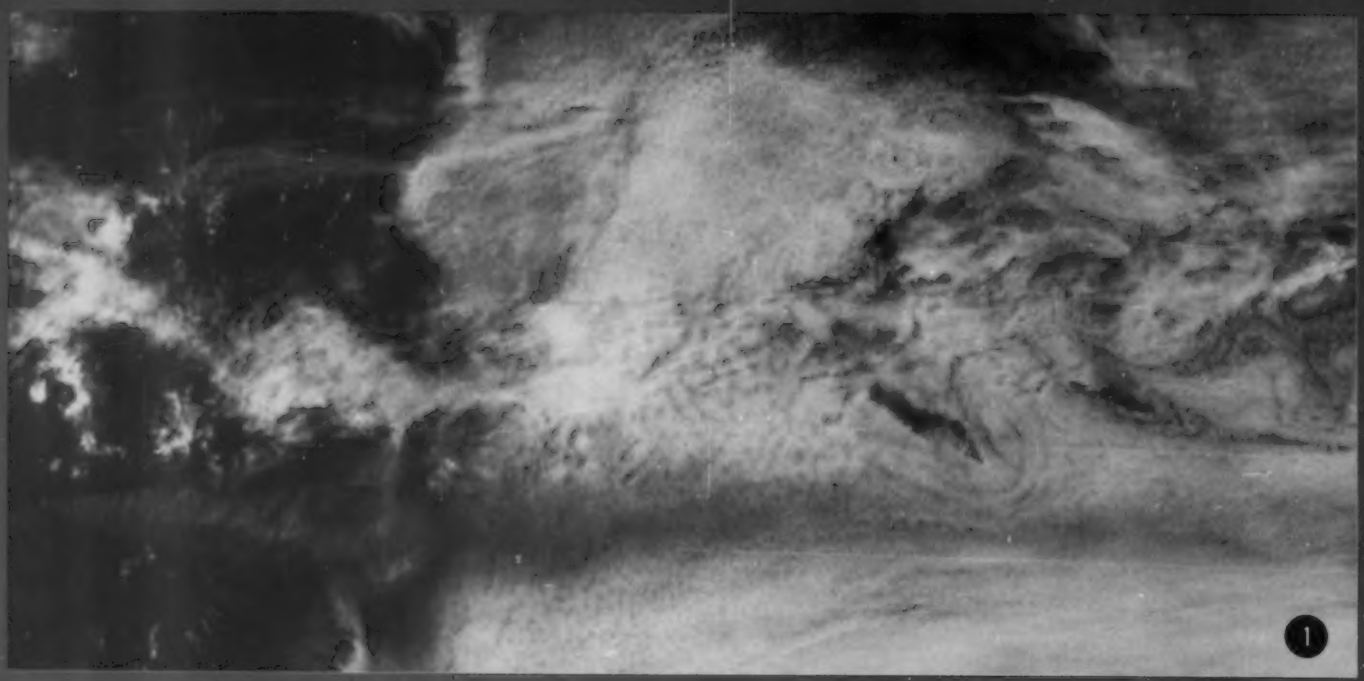
The prediction technique was developed as part of a five-year federal study—the Great Lakes-St. Lawrence Seaway Navigation Season Extension Demonstration Program. While the freezeup prediction technique was developed specifically for the international section of the St. Lawrence River beginning at Kingston, the site of Lake Ontario's outflow to the Seaway, NOAA scientists say the technique may also be applied to the St. Marys River, the outlet of Lake Superior, and the St. Clair River, outlet of Lake Huron. Both rivers have lakes with large heat storage capacities as their sources, similar to the St. Lawrence River and its link to Lake Ontario.

Preparing such forecasts for the other rivers linked to the Seaway would be a still greater boon to shippers using the waterway. According to figures published in late 1974, cost benefits to the United States alone would amount to approximately one million dollars for each day the system was open after December 15. But this figure is only a fraction of the amount that could be saved by the international community.

More than 50 countries presently use the St. Lawrence Seaway system. With operating costs running between $3,000 and $5,000 per day for ocean-going vessels, more accurate predictions by NOAA scientists of the exact date the locks would close at Massena could save thousands of dollars more daily. From some Great Lakes ports the Seaway route to Western Europe is shorter than the trans-Atlantic routes from the East coast of the United States. And all of the Great Lakes ports are hundreds of miles nearer Europe than are the Gulf Coast ports, which must be used as an alternative during the winter months. Direct commerce between the Great Lakes ports and overseas areas accounts for about one-quarter of the St. Lawrence Seaway's cargo tonnage, or approximately 12,500,000 tons a year.

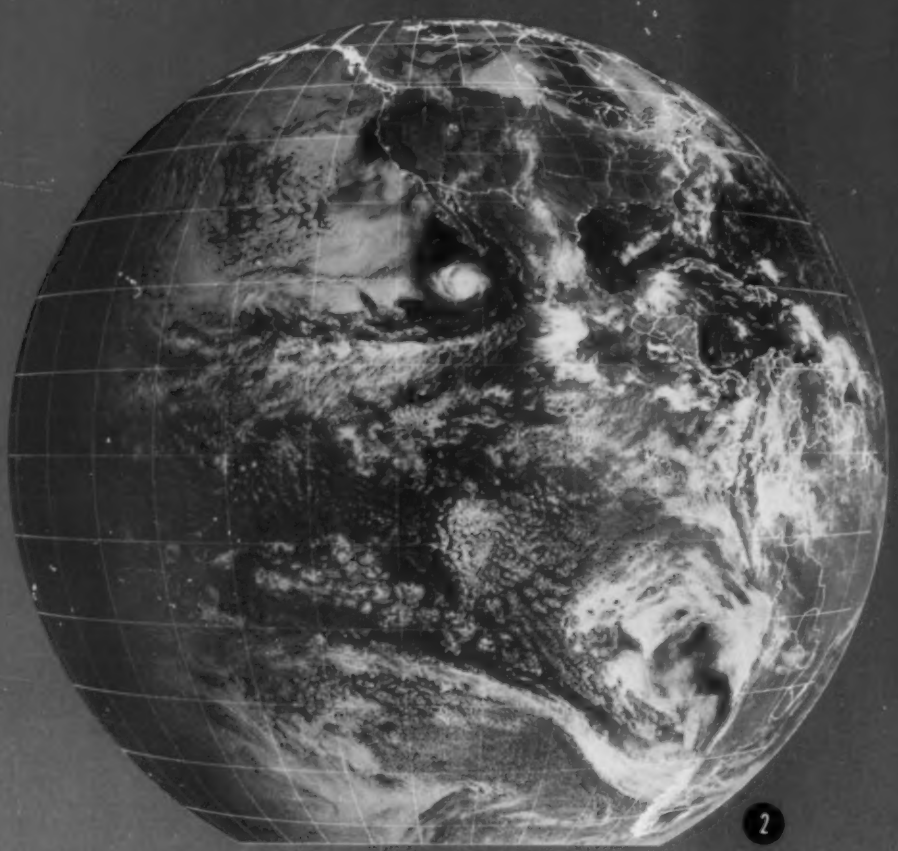
More precise predictions of the annual December freezeup would also affect costs of transportation within the Great Lakes region. Domestic industries using bulk commodities such as iron ore, coal, stone, and grain, which are transported on the Seaway system via huge 25,000-ton "lakers" during the open navigation season, must stockpile resources for winter production needs annually.

Each day the Seaway can be used in winter reflects improved efficiency in terms of low energy utilization and savings to the shipping industry. And the number of days the Seaway can be used depends upon how precise the annual freezeup predictions can be made. Businessmen in the Great Lakes community and throughout the world are gambling that NOAA can reveal nature' timetable, for the economic stakes are high.



1

THE VIEW FROM SPACE



2

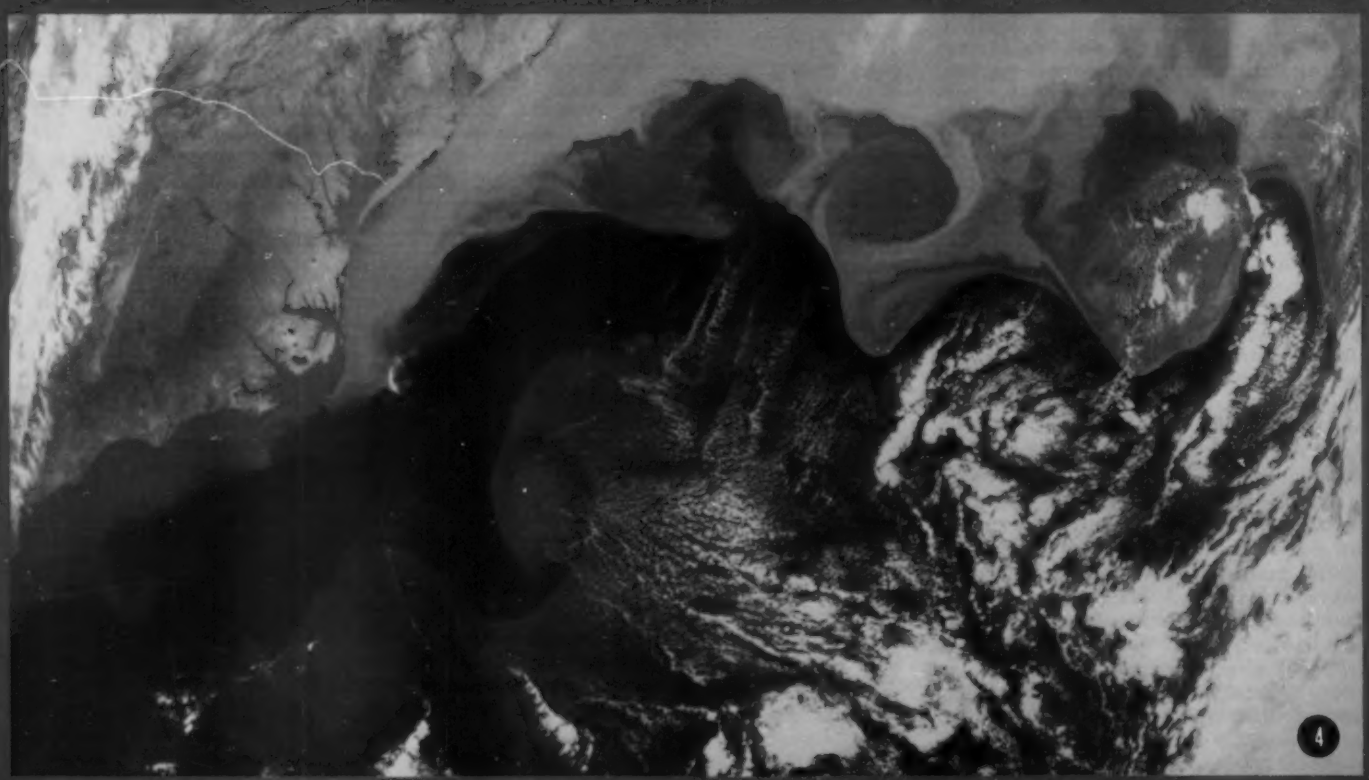
The launching in October of the GOES-A satellite—NOAA's first operational geostationary satellite—and the scheduled launch in February of ITOS-E2, a polar-orbiting environmental satellite, serve to focus attention on NOAA's National Environmental Satellite Service and its main product, space imagery. On these two pages are examples; photographs of Planet Earth—or sections of it,—from outer-space, each demonstrating a different facet of the environmental monitoring program.

1 *The dark plume of erupting Tolbachik volcano on the Kamchatka peninsula of USSR streams eastward for at least 960 km over the Pacific Ocean in this July 28 picture from the NOAA 4, polar-orbiting satellite. VHRR and infrared pictures permitted analysts to determine the dispersion of volcanic ash and the energy released by the volcanic eruption.*

2 *The full earth disk, with the Western Hemisphere artificially outlined for reference, shows global weather patterns in this picture from the geostationary satellite SMS-2, positioned some 36,200 kilometers above the equator over the eastern Pacific Ocean. While the continental United States is enjoying mostly clear weather on September 2, 1975, a hurricane—Katrina—is churning off Baja California.*

3 *Smoke from Los Angeles' devastating forest fires of late November drifts far into the Pacific Ocean in this dramatic photograph from polar-orbiting NOAA-4 satellite which illustrates the velocity of westerly winds which fanned the fires.*

4 *The Gulf stream in infrared imagery is clearly outlined as it curves up the eastern seaboard. Measuring temperatures with its scanning radiometer, NOAA 3 spacecraft shows cooler surfaces such as clouds, snow, and much of the land as white while warmer surfaces appear progressively darker. In this April picture, coastal waters are still cold. Shipping interests utilize pictures of this sort, catching the Gulf Stream current northbound to save fuel and time, avoiding it if sailing southward.*



The Old Familiar Puzzle of the Tides

BY LOUISE A. PURRETT

One of the most familiar things in the world—the ebb and flow of the tide—is one of the least understood. Humanity must have noted this rhythmic movement of the seas thousands of years ago, seeing the waters alternately claim and then surrender the shore.

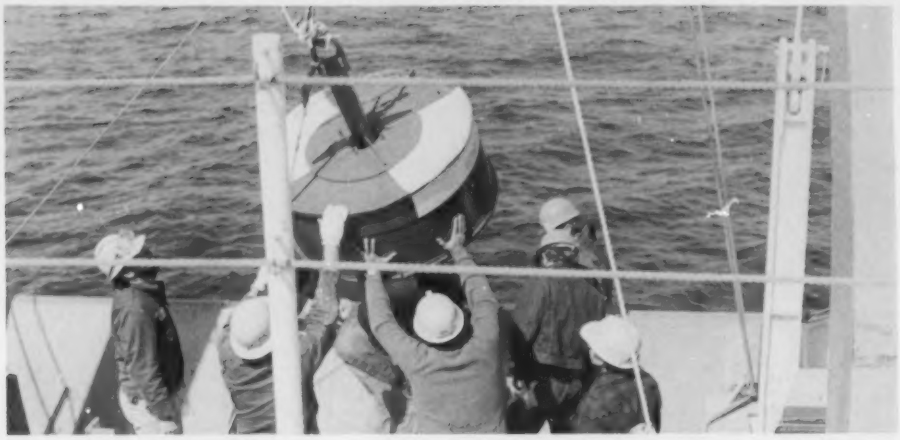
The beginnings of tide research are nearly as remote. Someone, at some forgotten time, must have noted the regularity of the tides and realized that they could be predicted. But it was a purely empirical science; accurate predictions of tides were possible long before anyone understod what caused them, or what made them vary from harbor to harbor.

Scientists now know that tides are caused by the gravitational pull of other bodies in the earth's neighborhood—mostly the moon and sun—and that there are tides in the "solid" earth and the atmosphere as well. But the movements of the sea are frustratingly complex. There are currents, waves, and surges pushed up by storms, and the infinitely varied bottom topography imposes its influence on the tides, making them rise higher or rush faster. The relationships between all these movements and forces has remained a puzzle.

The tides are not just a phenomenon of the shore, either. They are a back-and-forth movement of entire oceans. But until very recently, the behavior of tides at sea was completely unknown. And, though tides in many harbors can now be predicted years in advance, it remains largely an empirical science. Theoretical understanding of the forces that move and shape the tides is just emerging.

Scientists at NOAA's Atlantic Oceanographic and Meteorological Laboratories in Miami are working to fill this void. In a program headed by Dr. Harold Mofjeld, they are measuring tides in the deep ocean, generating computer models of tidal patterns, investigating the possibilities of measuring them from space, and examining the role of tides in the interaction between the human race and its environment.

To measure tides in the ocean basins, new tools had to be found. The earliest tide gauges probably consisted of notched poles planted a few feet out in the water, or high-



The drum-shaped float of a deep sea pressure gauge array is put over the side and the entire array streams out in proper order (See diagram on page 44) before sinking to the ocean floor; above a shallow water tide gauge is deployed; and at left technician Benjamin Culverhourse checks a shallow water gauge he built as tide program director Mofjeld and Researcher crewman Sam Kennedy look on.

water markers on the beach. These have evolved into a more sophisticated device—a tube containing a float that rises and falls with the tide, recording its movements on a graph. The principle was the same, however. Flotation tide gauges, like notched poles, measure the fluctuations of sea level directly, in relation to the sea floor. They are frequently attached to the ends of piers. To use the same system in the deep ocean would require a pier thousands of feet high.

So tide researchers had to find another way to measure changes in sea level—by changes in pressure. As the sea level rises, the weight of the water column increases. A pressure gauge on the sea floor can record the changes in the weight of the sea above. The Miami laboratory team has been applying this principle to measuring tides in the deep sea and along continental shelves.

One of the most concentrated studies of deep sea tides has been as part of the Cooperative Investigation of the Caribbean and Adjacent Regions (CICAR), a joint oceanographic study of the Caribbean and Gulf of Mexico by the United States, Mexico, Venezuela, Cuba, and other nations surrounding the two bodies of water, as well as the Netherlands and the U.S.S.R.

During this continuing program, scientists from the Miami laboratory, one of NOAA's Environmental Research Laboratories, deployed five deep-sea tide gauges in the Gulf and Caribbean. Dr. Bernard Zetler, who founded the NOAA laboratory's program and was the first director of the Physical Oceanography Laboratory, was particularly interested in studying the Caribbean as a smaller, more manageable model for the major oceans. The Caribbean also has some characteristics that make it inherently interesting to oceanographers. For example, in the Atlantic, tides occur twice a day, with about 12 hours, 25 minutes between high tides. In the Gulf, they occur only once a day.

One theory is that the Gulf has a natural resonance near the daily tides.

The NOAA Miami researchers were also particularly interested in seeking amphidromic points—places from which tidal motions radiate and where up-and-down tidal motion vanishes to zero. As water sloshes back and forth in a basin, with one side rising while the other sinks, there is a point in the middle, like the pivot of a teeter-totter, where the water is nearly still.

Between July 1971, and January 1973, five tide gauges were deployed in the Gulf of Mexico and the Caribbean as part of CICAR. The gauges were located near suspected amphidromic points predicted by theoretical models. Current meters were installed 33 feet (10 meters) above the bottom of the Yucatan Strait to measure tidal flow between the Gulf of Mexico and the Caribbean and help pin down daily tides in the Gulf. One of these meters showed a southward flow from the Gulf into the Caribbean that continued throughout the month-long period of observation.

The search for amphidromes was frustrated. The researchers concluded that "a program to locate an amphidrome precisely is self-defeating and the location can only be approximated by a grid of tide observations spanning the geographic position"—or by longer-term observations using higher-resolution instruments that can separate other movements of the water from any true tidal movement.

CICAR also promoted a number of inno-

vations and improvements in tide gauge systems. At Zetler's request, the National Ocean Survey's Engineering Development Laboratory devised a new system of deploying and recovering the pressure gauges. The pressure sensor is mounted on a heavy tripod base that rests on the ocean floor. A current meter, flotation units, a beacon transmitter and beacon light float 100 feet (30.5 meters) above the base, on a steel cable. The entire array, over 130 feet (40 meters) long, is deployed from a ship. When the oceanographers reach the site where they want to drop the tide gauge, the array is suspended from a large flotation sphere trailing behind the ship. A tilt sensor lets the scientists know if the cable has become tangled around the tripod. When they are satisfied that the array is hanging vertically, they release it, to sink to the bottom.

When the scientists are ready to recover the gauge, an acoustical signal from the ship activates the gauge's transmitter, which reveals its exact position on the ocean floor. The researchers position the ship above the gauge and then another signal from the ship sets off an explosive squib that releases the rest of the gauge array from its expendable anchor. The array floats to the surface, where the radio beacon and flashing light help the oceanographers find it in the expanse of ocean.

A new shallow water mooring system, similar to the deep sea system, was also developed to measure tides on shallow banks in the Caribbean and on the continental shelf.

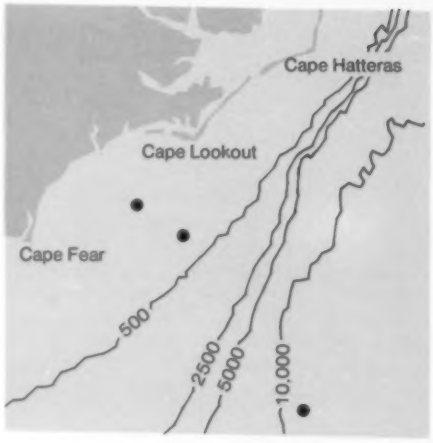
Parallel to the pressure measurements, Zetler made shore-bound tide measurements with flotation type tide gauges for a period of a year south of Puerto Rico. He found considerable variation between one-month segments of his record, and concluded that a month, the usual length of tidal studies, may not be long enough for reliable measurements where the amplitude of the tides is small, as it is near amphidromes. He decided that the pressure sensing systems should be modified to record fluctuations over longer periods. The Engineering Development Laboratory came through again. The result was an instrument system that automatically measures bottom tides for as long as six months, and can detect changes in water height of less than a centimeter (.4 inch) at depths of more than three miles (4.8 kilometers). The new system was used for periods of four and six months in the CICAR study, and the researchers obtained a four-month record of near-bottom currents in the eastern Caribbean that they believe will be very useful in studies of the sea's deep circulation. Mofjeld and Dr. Mark Wimbush of Nova University are still analyzing the CICAR results.

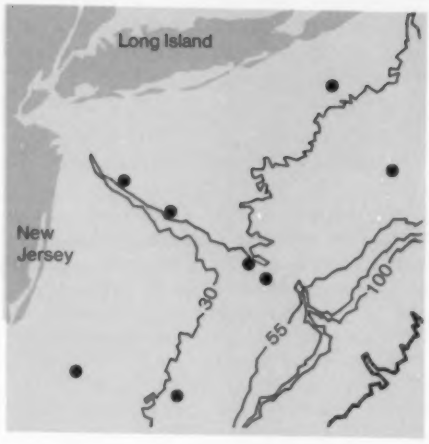
Another international experiment that had a completely different purpose turned out to be a fruitful source of deep sea tide measurements. The Mid-Ocean Dynamics Experiment (MODE) was an international effort to study part of the life history of an ocean eddy. During the 1973 experiment, researchers from a number of U.S. institutions—Yale, Woods Hole Oceanographic Institution, Harvard, Brown University, Scripps Institution of Oceanography, the University of Rhode Island, Nova University, University of Washington, and NOAA—joined scientists from Great Britain's Institute of Oceanographic Sciences to find and study an eddy 420 miles (700 kilometers) west of Bermuda, near the edge of the Gulf Stream. U.S. participation in both MODE and CICAR was funded by the National Science Foundation through the International Decade of Ocean Exploration.

To study the eddy, Mofjeld explains, the first step was to distinguish it from the multitude of other complex motions of the ocean, including tides. In subtracting tidal motion, the scientists incidentally obtained a unique set of tide measurements. In all, NOAA scientists, working with Zetler (who is now at Scripps' Institute of Geophysics and Planetary Physics) and others, deployed three of the deep-sea pressure gauges in the MODE study area.

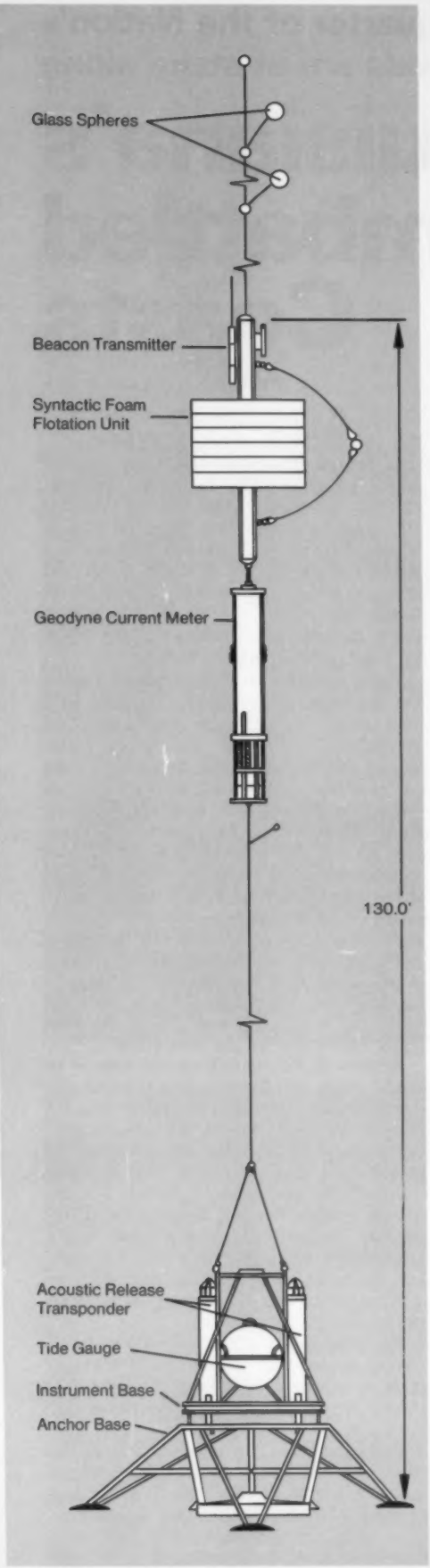
The researchers compared the tidal measurements with predictions of a theoretical model developed by a German scientist and with equations relating tides to friction, the Coriolis force (the effect of earth's rotation), and other factors.

Not all the tide research at the Atlantic Oceanographic and Meteorological Laboratories has been in the deep ocean. Between the shore, where the great bulk of tidal measurements have been made, and the deep ocean, is another area practically untouched by tidal research: the continental shelf. To study the transition of tides as





Above, maps of three areas in which NOAA researchers have gone to the sea floor with pressure gauges and current meters to gather information on the tides. At right, a schematic drawing of a deep water pressure gauge. They have been used at depths of up to 3.4 miles (5,500 meters) for six months.



they cross the shelf, NOAA scientists embarked on a field program to measure tides across the North American continental shelf off Onslow Bay, North Carolina.

For a month in the summer of 1972, three bottom pressure gauge and current meter arrays recorded pressure, currents, and temperature in the middle of the shelf 35 miles (56 kilometers) from shore, at the edge of the shelf 55 miles (88 kilometers) out, and in 11,00 feet (3,350 meters) of water 170 miles (270 kilometers) from the coast.

A similar set of measurements was made farther to the south, off Savannah, Georgia, in 1974. In a cooperative effort between the National Ocean Survey, the University of Miami, and the Atlantic oceanographic labs, four gauges were deployed in a line from Savannah Light to 240 miles offshore. One aim of the study was to determine how tides of the deep sea are related to tides and circulation over the submerged continental shelf and along the coasts. A single gauge previously deployed by the National Ocean Survey in the same area recorded tidal fluctuations at half-hour intervals for six months. The results from that gauge indicated that the average range of the tides in the deep ocean was approximately half that of coastal tides.

Pressure gauges, however accurate and reliable they become, have their limitations. For one, it is sometimes very difficult for scientists interpreting the pressure record to separate tidal effects from other sources of pressure change. During MODE, for example, Mofjeld and his colleagues found that they couldn't distinguish between surface tides and internal waves—up and down movements of water within the water column that have little effect on the surface. Another limitation of the gauge system is that each tide gauge measures tides only at one spot in the vast ocean and a great number would be needed to give an overall picture.

Satellites, from their vantage point in space, might be the answer. Altimeters on the satellite could measure the distance from the satellite to the surface of the ocean, explains Mofjeld. The distance would increase as the sea falls and decrease as it swells. Satellites would have the tremendous advantage, he says, of providing global coverage. He and another scientist at the Physical Oceanography Laboratory, Dr. George Maul, are now studying the feasibility of satellite tide measurements, using data from GEOS-3, a National Aeronautics and Space Administration satellite equipped with precision altimeters for measuring the geoid (the imaginary surface of the earth perpendicular to the direction of gravity). Mofjeld and Maul will compare satellite measurements with ground-based tide measurements made by traditional methods. The main problem, says Mofjeld, seems to be the accuracy of the satellite altimeters. Pressure gauges can measure sea levels changes of half a centimeter; the GEOS altimeters can only come within 20 centimeters.

The accuracy of satellite tide measurements also depends on how accurately the position of the satellite is known. Laser-ranging devices at Bermuda, Grand Turk Island in the West Indies, and along the U.S. coast will keep track of the satellite so that the researchers know its exact position over the Atlantic at a given moment. With data from MODE, the North Carolina and Georgia studies, Mofjeld has devised a computer model of Atlantic tides that will help guide the satellite study.

Meanwhile, the emphasis of the Environmental Research Laboratories' tide reseach has been shifting from basic research in the deep ocean to problems of the coastal environment. As part of a major NOAA study of the New York Bight, Atlantic Oceanographic and Meteorological Laboratories scientists deployed three pressure gauges in the Bight in the winter and spring of 1974. Last winter, five more, incorporating a new type of pressure transducer, were installed to monitor tides and storm surges, local rises in sea level pushed up by storms that may flood low-lying areas. Those gauges were retrieved in June, and the data are still being analyzed. The five gauges will be deployed again in the Bight this winter.

The aim of the New York Bight study, managed by NOAA's Marine Ecosystems Analysis Program Office, is to define the impact of the huge population of the New York metropolitan area on the marine environment. Tides, explains Mofjeld, affect the dispersion of pollutants placed in the Bight. The direction of tidal currents should be considered in planning dump sites, for example. The range of the tide—the difference between high and low tide—also determines the amount of flooding a storm surge may cause. Predictions of flooding are based on the amount that sea level may rise, and at high tide a rise of a given amount would have a greater effect.

To subtract possible weather effects from "true" tides in pressure records, the Atlantic Oceanographic and Meteorological Laboratories scientists needed accurate information on meteorological conditions in the Bight. At their request, the Buoy Office has anchored a meteorological buoy in the Bight to measure temperature, air pressure, humidity, wind, and other parameters. Another is planned for a site off the New Jersey coast. Mofjeld believes that when all these data are analyzed, tides in the New York Bight will be "pretty well understood."

Mofjeld predicts that NOAA tides research will focus more and more on the coastal environment. But the shift from basic, rather esoteric deep sea research to inshore research with direct practical applications is more apparent than real, he points out. "Little has been known about what goes on on the continental shelf. Very few measurements have been made on the shelf, and very few theories exist." So, though the aims are pragmatic, the research is still basic, for there is much to learn about the familiar tides. "We now have a lot of problems that make that knowledge necessary."

One-quarter of the Nation's wetlands are at stake along

Louisiana's Embattled Coasts

BY DIANE CATALANO*

Coastal Louisiana is a vast region extending west to the Sabine River, east to the Chandeleur Islands, south to the Gulf of Mexico, and bounded on the north by the five-foot contour line. Twenty of the state's sixty-four parishes (counties) are at least partially in the coastal zone, and half of these are entirely so. The population of the coastal zone, more than 1.5 million, is 41 percent of the State population and is increasing at a much faster pace there than elsewhere in the state.

The people and culture of the coastal zone also differ from other parts of the state and nation. Many are descendants of the original Acadians who came to southern Louisiana from a section of Canada then known as Acadia, now Nova Scotia, under the coercion of the British in 1755. As a result of this massive immigration, French culture has influenced the style of life in the coastal area. The Louisiana variety of French is spiced like its gumbo, and locally those of French ancestry are known as "Cajuns." But regardless of parentage, coastal residents partake in the Cajun culture with its frequent festivals and its "fais do-do", a friendly gathering with music and much dancing.

Louisiana cherishes the language and music of the coastal area. Many people speak French (Cajun French), especially among relatives and friends, and Cajun folksongs are still sung.

Folklore from southern Louisiana is rooted in the legacy of New World French culture. Many versions circulate of the story of the legendary lovers, Evangeline and Gabriel, who were separated on the journey from Nova Scotia. Bayou Teche and St. Martinville are frequent localities of these tales. Waterways such as Bayou Teche, Bayou LaFourche, the Atchafalaya River, the Mississippi River and the Vermilion River mark the locations of much of the folklore and history of coastal Louisiana because historically the many rivers and bayous of the state have provided easy transportation for the inhabitants. Louisiana's water resources have also traditionally provided recreation for people in the state and the entire southern region of the United States.

This way of life, and the uses of the wetlands, are changing. To assist the State of Louisiana better to plan these changes in the area that is so important to its culture and economy. NOAA's Office of Coastal Zone Management made an initial grant in 1974 for the development of a coastal zone management plan. An additional grant was awarded by OCZM in 1975.

Prior to that time, the State's Advisory Commission on Coastal and Marine Resources—created by the 1971 State Legislature—had produced a major report, "The Wetlands Prospectus," which listed the key issues and problems of the state's coastal area and laid the foundation for work that has been taken up by the Coastal Resources Program.

The area that the plan must deal with is vast—about 10 million acres—and diverse. Dry land accounts for about 1½ million acres, or 15 percent of the coastal zone. The wetlands of Louisiana are estimated to be about 8.5 million acres, or about 25 percent of the wetlands found in the entire nation. Swamps, distinguishable by stands of cypress and tupelo trees, stretch for over 1½ million acres through coastal Louisiana. The remaining wetlands are made up of a variety of marsh types—saline, brackish, intermediate and fresh marsh. These marshlands represent about 70 percent of Louisiana's coastal zone.

Louisiana's coastal marshland is the product of the Mississippi River which over the past 5,000 years has shifted across the southern part of the state from west to east as its mighty and muddy waters have rolled out to the Gulf. Seven Mississippi River delta systems during this period have caused the considerable variation in the physiography of coastal Louisiana. The land along the coast meets the water in a highly irregular shoreline of bays and inlets which gives Louisiana a unique and extremely long shoreline. This irregular pattern of land and water interface contributes greatly to the fish and wildlife productivity of the state.

It has been estimated that an acre of marsh produces more food than acres of carefully tended agricultural land. Marshes also serve to protect man from the severity of storms by acting as a buffer. By absorbing the enormous energy of storm waves and acting as a water reservoir for coastal storm waters, the marsh reduces the severity of storm damage and flooding farther inland by functioning as a giant sponge.

These valuable areas in southern Louisiana are being subjected to alterations that permanently change the unique character of the terrain. For instance, diking and drainage of the marshland for agricultural uses has decimated the original marsh as well as having proved unsound, in many instances, from an agricultural standpoint. Urban expansion into the wetlands has occurred as metropolitan areas of the state such as New Orleans and Lafayette have grown in population. And recent reports indicate that prime agricultural lands in southwestern Louisiana are being used for residential development. It has been predicted that if the present draining and filling operations in the state continue, 186,000 acres of Louisiana's wetlands will be lost by the year 2000.

Activity in Louisiana's coastal zone is so intense that of all the permits issued nationally by the Corps of Engineers, over 50 percent are issued in this state. Since present permits are handled on a project-by-project basis, the cumulative impacts along the coast can be largely ignored. For instance, a single housing development or industrial installation built near shore rarely has a significant impact on a coastal system, but the combination and accumulation of such activities can be severely detrimental to the coastal environment.

Realizing this, the Advisory Commission recommended that coastal zone management in Louisiana be directed toward a dual effort—long range planning and day-to-day management.

The Louisiana CZM program is being developed in cooperation with other federal agencies and with the State Wildlife and Fisheries Commission, the Sea Grant Program, and the Louisiana Coastal Comission. The goal is to balance conservation and

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Diane Catalano is Public Affairs Assistant, Louisiana Coastal Resources Program, State Planning Office.

development by encouraging reasonable and suitable uses of coastal lands. Because so much of its coastline are wetlands, Louisiana's coastal management program will have a decided wetlands focus.

Efforts toward formulating Louisiana's coastal zone management plan have been divided into discrete task areas. For example, the State Planning Office has the responsibility for assessing and projecting growth trends in coastal Louisiana. The office is also responsible for developing public participation in the program. Through the summer and fall of 1975, it held nine meetings throughout the state to acquaint legislators and the public with the issues and problems facing Louisiana's coastal lands.

State Senator Jesse Knowles, after attending a meeting for public officials, stated that "a comprehensive coastal management plan is needed," and added that he favored coastal zone management legislation for Louisiana.

Other public presentations were conducted around the state to foster greater understanding of the complex coastal issues and workshops are being planned. The Coastal Resources Program is directing efforts at cooperating with local government and other state agencies to help citizens better use and conserve the state's natural resources.

Representatives of the Sea Grant legal program have traveled throughout Louisiana's coastal parishes to interview chief administrative officers and to collect ordinances that control or affect coastal resources.

Since a large quantity of state and federal lands are in the coastal zone, the planning office has prepared a listing of the lands and is in the process of identifying for each tract the agency responsible for it, and the procedures by which the agency makes land and water use decisions.

Joel Lindsey, Director of Public Affairs for the Louisiana coastal program, said the state has sought and found federal cooperation. "We are encouraged by the interest federal agencies have shown in coastal zone management. Through several meetings with the Federal Regional Council in Dallas, we have gotten down to the substantive issues."

Early in its program, Louisiana asked the Southwest Federal Regional Council to organize a forum so that affected federal agencies could convene to comment on the development of Louisiana's program. On July 1, 1975, and again in August, the Coastal Zone Ad Hoc Committee met in Dallas to address two of the more difficult issues facing coastal zone planners: identifying federally-controlled lands and determining the national interest, from each agency's perspective.

"All of the participants feel positive about using this regional forum," said Carol Sondheimer, Southern regional coordinator for

Illustrative to the varied environment of Louisiana's embattled coasts are the roosts of brown pelicans (above), and an offshore oil platform, common sight in the Gulf of Mexico.

Louisiana's wetlands, which make up about 25 percent of all the nation's wetlands, play host to a wide variety of human activities dependent upon their specialized and fragile nature, such as oyster aquaculture (above) and small boat use for transportation, pleasure and subsistence fishing (right).

NOAA's Office of Coastal Zone Management.

As regional coordinator, Ms. Sondheimer spend much of her time working with Louisiana and other southern states to help their programs toward final federal approval.

Louisiana marshes and estuaries are dynamic with dramatic variations of salinity, water circulation, soil erosion and accretion, hurricanes and storms, flooding, rainfall and climate. They are part of a valuable ecosystem that yields untold benefits to man. The Coastal Zone Management Plan is aimed at ensuring that these benefits continue to be available.

The estuaries support aquatic life and provide Louisiana with an abundant renewable resource. Important recreational and commercial fish yields in Louisiana include shrimp, oysters, menhaden, crabs and crayfish. Shrimp are in greater concentrations in Louisiana estuarine waters than along the east and gulf coasts and although many species of fish such as the menhaden are frequently harvested offshore, they are nevertheless dependent on the estuaries. The menhaden's young migrate from offshore areas to grow and mature in the shallow estuaries of the coast.

Beyond their impressive biological productivity, the marsh and estuaries render other services to man.

One is waste treatment, which an estuary can accomplish up to a point without an appreciable reduction water quality. Marshes and estuaries are particularly effective and suitable in tertiary treatment of waste—a costly process if carried out in artificial systems.

Other functions of the marsh include its important role in global cycles of nitrogen and sulfur. The continuing normal function of the biosphere depends on the chemical reduction of carbon, nitrogen and sulfur which are incorporated into all living tissue, and wetlands aid in these processes.

Louisiana's entire coastal area also provides a habitat for multitudes of migratory birds such as ducks, geese, sandpipers, plovers, swallows, warblers, and sparrows. Much of the southward bird migration in North America is funneled down the great Mississippi River Valley to coastal Louisiana. It has been estimated that 62 percent of the bird species found in Louisiana are migratory.

The esthetic pleasure and sport hunting recreation man derives from these migratory birds is not confined to southern Louisiana, but extends northward over the continent.

Man has tried to protect himself from the ravages of flooding by controlling the flow and course of the Mississippi River with extensive levees, but with some unhappy consequences. In the past, the sediment of the river filled shallow waters of the inner continental shelf and produced the deltaic plain. Today, the present delta has stretched out to the edge of the continental shelf and the 250 million tons of sediment per year is being dropped into the abyss off the edge of the continental shelf. Deterioration of the delta occurs when it is deprived of its necessary supply of river-borne sediment. It is estimated that Louisiana is presently losing about 16.5 square miles of land every year. In addition, the levee system has robbed the estuaries of the flow of fresh water, which causes salt water intrusion into previously fresh or brackish areas.

Others factors also are taxing the existence of wetlands. The dredging of canals through the wetlands for navigation, for laying pipelines and for access to oilwell drilling sites, can alter water circulation patterns. A result is augmented salt water intrusion. Farmers in extreme South Louisiana are well acquainted with this, and talk of their first-hand experiences with ruined crops as a result of salt water encroachment. Salt water intrusion kills cypress, tupelo and fresh water vegetation. This in turn causes erosion which speeds further salt water encroachment.

In 1901, oil was discovered in Jennings, in southwestern Louisiana. Since then the development of the oil and gas industry has significantly contributed to Louisiana's economic growth and the State ranked second in oil production among the 50 states.

At present, about 50,000 workers are engaged in oilfield operations, and many coastal cities such as Venice along the Mississippi River, Grand Isle, Leeville, Houma, Morgan City, New Iberia, Lafayette and Lake Charles have grown and prospered economically as service centers for offshore activities.

While the entire state of Louisiana produces oil and gas, southern Louisiana, and more specifically the coastal zone, provides most of the state's production. But a majority of oil and gas wells in the coastal zone are in swamps and marshes, and canals must be dredged into these areas to facilitate drilling operations. These canals can have an adverse effect on the natural system of wetlands.

Dr. L. S. St. Amant, Assistant Director of Louisiana Wildlife and Fisheries, and one of the first critics of irresponsible oil operations in coastal areas, says, "I suspect the Louisiana coastal area has been subject to every type of petroleum environmental threat that could be thought up. We survived. We learned from hindsight. And mistakes we made can be avoided by the newer offshore areas."

Presently, two discernible trends with respect to Louisiana's gas and oil production will have serious economic consequences for the state. First, Louisiana is said to be running out of oil and gas. Excluding federally owned offshore production, Louisiana's petroleum production has steadily declined, as have known reserves, since 1970. Secondly, offshore activity which in 1947 began only a few miles off Louisiana's coast can be expected to move farther offshore into federal waters. As this occurs, Louisiana must prepare for the socio-economic and environmental impacts that will likely result onshore.

Through coastal zone management, Louisiana's Coastal Resources Program is endeavoring to pinpoint and analyze future impacts caused along shore, through production on the Outer Continental Shelf and other coastal developments, so that these impacts can be minimized. As one official put it, "What Louisiana needs is careful planning now, and coastal zone management is the best answer."

Requiem for Thirty-nine Charlie

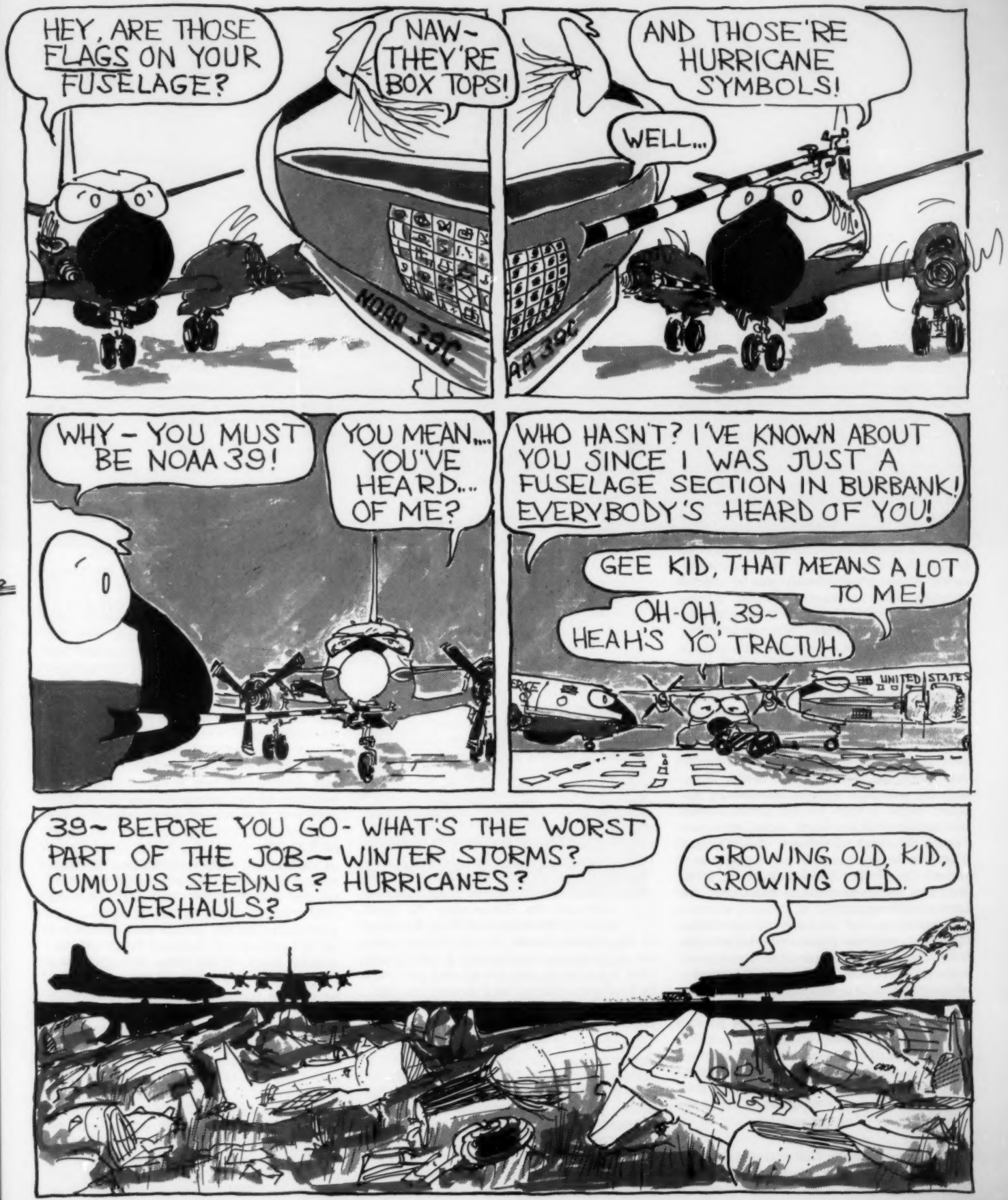
For 39 Charlie, the end came on December first, when the venerable DC-6B's research career came to a quiet stop at the Air Tech hangar NOAA occupies at Miami International Airport.

There has been no career quite like 39 Charlie's. The airplane flew some of the world's most difficult atmospheric terrain, from the Indian Ocean monsoon to the tropical Atlantic to the turbulent interiors of cumulus towers. Hurricane symbols on the fuselage denote 321 penetrations of 42 hurricanes. The aircraft bears the flags of 40 nations and one territory, many of whose scientists have used this research platform's unique capabilities. Probably there is not another aircraft in the world that has done so much to advance our knowledge of the atmosphere and ocean.

NOAA 39 also represents a milestone in the way aviation has been applied to the work of doing science in the sky. What is now the National Weather Service noted in the 1950's that a serious effort was required to field airborne platforms for hurricane research. Accordingly, two DC-6 aircraft were obtained in 1959 from Trans-Caribbean Airlines, and the U.S. Air Force transferred title of a B-57 jet to the Department of Commerce. NOAA 39 is the only survivor of that old trio of research aircraft, and that career has now ended.

The DC-6 leaves an organization that is greatly changed from the old days. Now called the Research Facilities Center, NOAA's aviation group has become a national center of excellence for using aircraft to extract information from the environment. The new equipment reflects that. NOAA 42, a WP-3D delivered by Lockheed-California in Burbank last June, is on the line in Miami now, being readied for research. This month the second WP-3D, NOAA 43, will be delivered in Burbank. These, together with NOAA 41, the C-130, will constitute one of the world's most advanced squadrons of research aircraft.

The New Kid
WOW! MIAMI INTERNATIONAL! THE BIG TIME ~ AT LAST!
THIS'LL GET YOU RIGHT HERE - IN THE OIL FILTER.
N42RF
HEY, 39 ~ LOOK THEAH.
YEAH ~ MY KID REPLACEMENT
NOAA 39C
HI, GUYS ~ KNOW WHERE NOAA KEEPS ITS PLANES?
NOAA? PLANES? THEY USING ELECTRAS NOW?
I'M NOT AN ELECTRA! I'M AN ORION! I'M NOAA 42!
YOU LOOK LIKE ONE TO ME.
COME ON, 39, AIN'T NO CALL T' BE MEAN T' TH' KID!
NOAA 39C
NOAA 41C


HEY, ARE THOSE FLAGS ON YOUR FUSELAGE?
NAW- THEY'RE BOX TOPS!
NOAA 39C
AND THOSE'RE HURRICANE SYMBOLS!
WELL...
AA 39C
WHY - YOU MUST BE NOAA 39!
YOU MEAN... YOU'VE HEARD... OF ME?
WHO HASN'T? I'VE KNOWN ABOUT YOU SINCE I WAS JUST A FUSELAGE SECTION IN BURBANK! EVERYBODY'S HEARD OF YOU!
GEE KID, THAT MEANS A LOT TO ME!
OH-OH, 39- HEAH'S YO' TRACTUH.
UNITED STATES
39- BEFORE YOU GO- WHAT'S THE WORST PART OF THE JOB- WINTER STORMS? CUMULUS SEEDING? HURRICANES? OVERHAULS?
GROWING OLD, KID, GROWING OLD.

One man's fortitude during the stormy early days of the National Ocean Survey left the United States

Hassler's Legacy

BY ALBERT A. STANLEY*

In the early years of the Republic, communication by land was meager, hazardous at times, and slow at best. Therefore the principal modes of transportation and communication between the colonies of Colonial America were by sea.

Moreover, young America at the turn of the 19th century was experiencing a tremendous growth in maritime commerce. Heavily laden cargo vessels and passenger ships with their precious burdens were entering and departing American ports for all parts of the world. The Louisiana Purchase created a special requirement for definitive coastal delineations. Since most communication between the colonies was by coastal shipping, it was paramount that critical coastal areas should be surveyed and adequate charts produced. This undertaking was essential to the new Nation's growth and progress.

Charts then in existence consisted chiefly of those produced by the British Admiralty of Colonial America for use prior to and during the American Revolution. These charts were based upon vague and incomplete reports and sketches, and were totally inadequate for needs of the times. Fragmentary measures were undertaken by the infant republic with localized and limited investigations of the coast, including a survey of the coast of Orleans in 1805 incidental to the Louisiana Purchase and a survey of the North Carolina coast in 1806. No effort had been made to coordinate the land or water surveys.

Commerce and industry concentrated along the Atlantic coast, with waterborne traffic the principal means of transportation, required immediate attention in the interest of economy, safety, and expediency. A decade or more before this time, a report had been made by a special committee of the Third Congress on February 27, 1795, which stated that the seacoast, not only of Georgia but also of South Carolina, North Carolina, and Virginia had never been surveyed with the requisite accuracy and concluded with the recommendation for the adoption of a resolution requesting and authorizing the President to cause a survey to be made of the coast between Chesapeake Bay and St. Mary's River. An additional report of like substance was made to the Fourth Congress.

These proposals generated debate and speculation until President Thomas Jefferson, in an address to the Ninth Congress in 1806, recommended the establishment of a "Survey of the Coast." On December 15, 1806, a U.S. Representative from Connecticut addressed the House upon the need of a survey of the whole extent of the coast of the United States. A bill was reported out of committee on January 6, 1807, and after amendment was passed and approved by President Jefferson on February 10, 1807, to provide for surveying the coast of the United States.

Execution of the Act of 1807 was assigned to the Treasury Department, under Secretary Albert Gallatin, who promptly issued a circular requesting men of science to submit plans for creating the first civilian scientific agency of the Federal Government. Of the thirteen plans submitted, seven were seriously considered but that by Ferdinand Rudolph Hassler, a leading international scientist born in Switzerland and residing in the United States since 1805, was accepted.

The Hassler plan reflected a thorough grasp of the problems involved in such a momentous undertaking. It drew from his experience in conducting field work on a trigonometric survey of his home district in Switzerland. The Hassler approach to the problem demonstrated a uniquely advanced knowledge of the entire field of geodesy in which he had gained international recognition. With the full support of the American Philosophical Society, he was appointed the first superintendent of the survey.

The Hassler plan prescribed the execution of a system of triangulation along the coast by which all detailed surveying operations would be controlled in accuracy, with each separate unit fitting exactly into the overall scheme. The plan presented two methods—the first by a complete triangulation survey of the whole coast, including the determination of the latitude, longitude, and azimuths of the principal places, such as lighthouses, capes, or prominent landmarks. The sides of the triangles were to be from about 60,000 to 100,000 feet in extent, resting on two or more bases—the baselines to be measured with all possible accuracy. The second method omitted the large triangulation, but retained the design of fixing the prominent points and features of the shore, by the same method of determining by astronomical observations their latitude and longitude, and correcting the differences in time, by the comparison of good chronometers. Details were to be filled in by appropriate instruments as circumstances might direct. The first plan was adopted as being more feasible and plans were made accordingly.

A principal element of the survey was to form a chain of triangles, with sides about thirty miles in length along the entire coastline, determining the azimuths of their sides and the latitude and longitude of their angular points. Within the large triangles were to be formed another series of triangles about ten miles along each side to provide an ample number of determined points to which the survey may be referred in all its detail. The entire net was to rest upon two or more baselines, measured with an accu-

Mr. Stanley is the National Ocean Survey's Special Assistant to the Director for Bicentennial Affairs.

racy to be obtained by methods and equipment to be designed as experience dictated. The baseline apparatus was perhaps the most original feature of the equipment assembled for the survey. It was based on an entirely new concept, Hassler's own.

After a lengthy trip to Europe, Hassler returned with an array of surveying equipment, build in accordance with his design, which was the envy of all surveying organizations of the leading nations.

Before any field work was started Hassler conceived the idea of a unique means of transporting his delicate instruments. He designed and had built by Camfield of Newark, N.J., a spring carriage of exact dimension and arrangement to accommodate his instruments. Hassler's famous yellow, horse-drawn travelling carriage was at first intended to carry instruments from station to station rather than by hand as had been the case in Switzerland. The specially designed conveyance was found to be the best means of transporting the instruments, some weighing 100 or more pounds each, over difficult mountain roads.

The coachmaker was directed to build a box that would hold the instruments snugly against each other so as to prevent jarring and damage from shaking. The carriage had a folding top for protection against rain. The wheels were extra wide and were made lower than a conventional Jersey wagon. The body was suspended upon strongly built, heavily braced C springs arranged so that the instrument boxes would stand even. In a locker under the seat, Hassler carried his extra clothing and a supply of Swiss wine, crackers and cheese to sustain him in the field. With its suspended table, the vehicle served as Hassler's office by day and, with the table secured, as sleeping quarters by night. In the spring of 1817, field work with the new instruments was initiated near New York City.

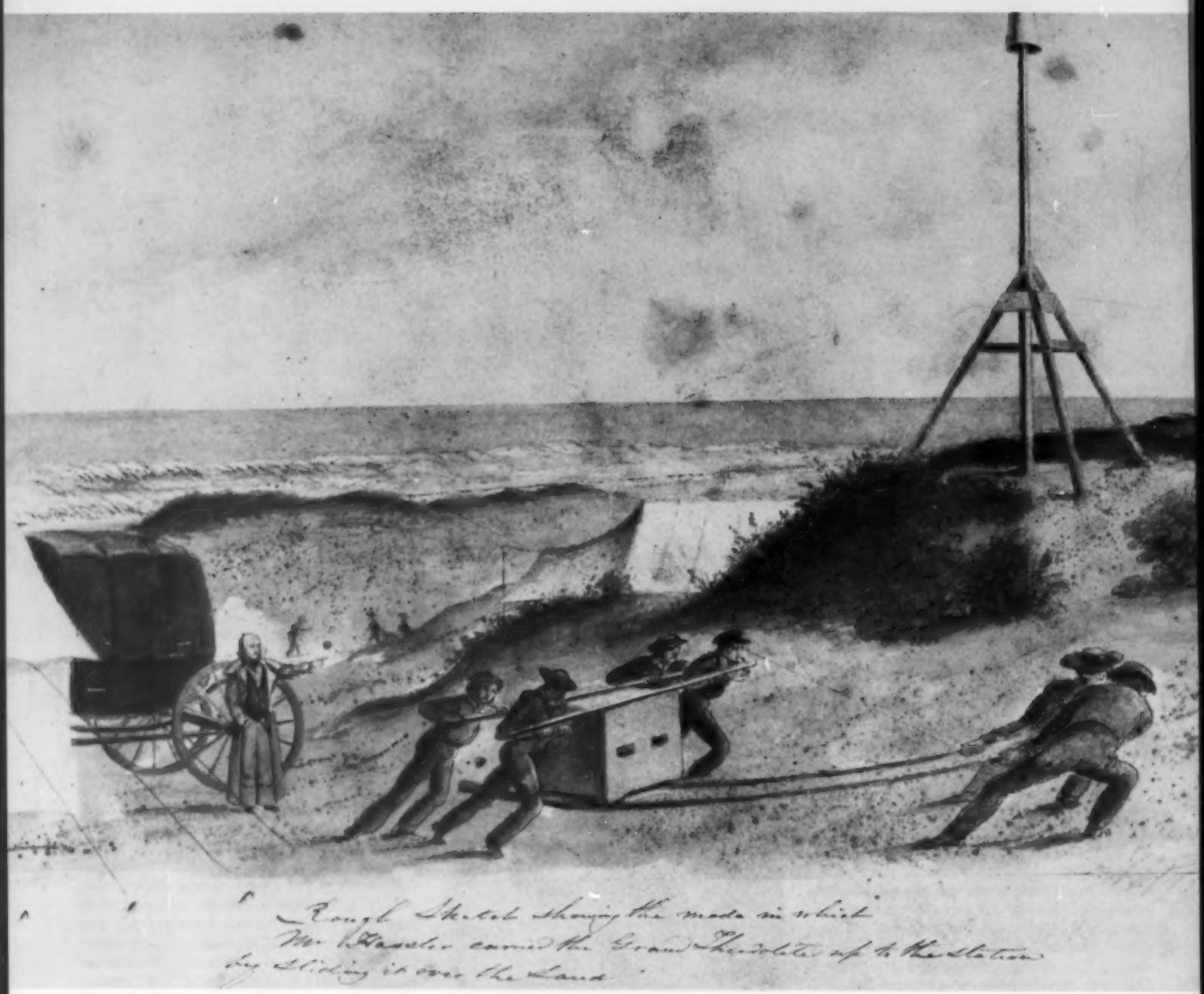
Making a base line measurement, using equipment designed by Ferdinand Rudolph Hassler, above. Below, Pro. Hassler's tent, with 30-inch Great Theodolite mounted inside (1838).

After only five months in the field in 1817 agitation in Congress, reflecting a dissatisfaction with progress being made, brought a suspension of the work. This ushered in some fourteen years of the "Dark Ages" of the Coast Survey.

Hassler was not idle, however. He constantly emphasized the necessity of an accurate triangulation made with the best means that science and its auxiliary arts afforded. In reply to his critics, especially those who held that there existed in the United States a native talent abundantly sufficient for the management of institutions such as the Coast Survey without the use of foreign-born, Hassler affirmed that "the nation that excluded from itself the admission and use of foreign talents and knowledge, must always remain behind in the paths of civilization, and will appear comparatively barbarous, if not really so." He further stated as a precept that science, arts, and ideas for improvements are the common property of all nations which serve as their mutual ties; and cannot be succesfully cultivated without free intercourse, exchange, and intermixture.

In resuming work in 1832, the Superintendent, then 62, adhered to the principles he had prescribed. He adhered to unity by the shortest route by using the largest triangles that the localities of the country could accommodate. This often required the work to recede more or less from the outer limits of the seashore, due to a large part of the coastal zone being low, level, and bordered by forests and marshes with no prominent objects.

Hassler emphasized that the many and varied observations and other works, could not be performed by a single person, but


Rough Sketch shewing the mode in which
Mr Hassler carried the Great Theodolite up to the Station
by sliding it over the Sand

The Great Theodolite is laboriously dragged up to its station by the survey party by sliding it along the sand.

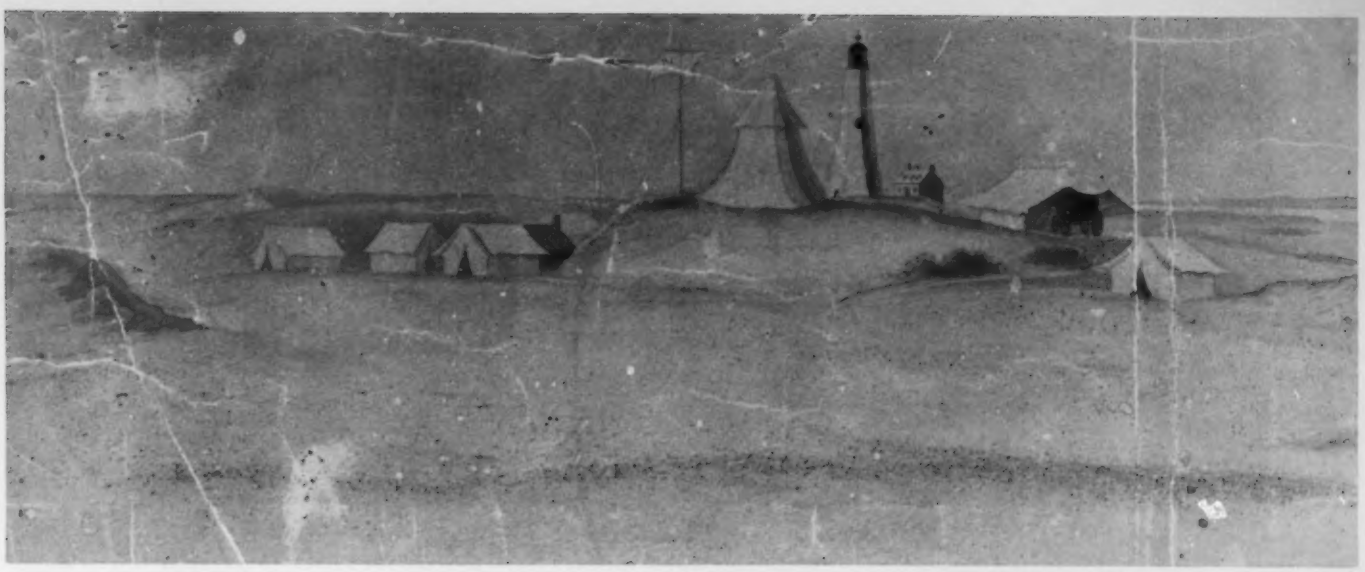
that trained assistants were essential. He prescribed that a full, clear, and minute scientific account must be published of the entire work from the initial observations up to the final results. The main objective of the Coast Survey, if it were to deserve the attention, respect, and confidence of the nation should employ a systematic trigonometric operation, with its accompanying astronomical part.

He prescribed many additional guidelines. Work was to be executed by the best means and methods obtainable from qualified engineers and devised by science. The Superintendent held that the more perfect the means to be used and the qualifications of assistants, the quality of instruments and all that can facilitate the observation and other works, the more fully will the objectives be met to become the base and standard of any future surveys that may be desired. The survey must present, not only the delineation of the shoreline, the soundings, and what may appertain to the safety of navigation, but also all that can in anyway be useful for the direction of the defense of the coast.

Hassler consistently declined to answer those who repeatedly demanded an estimated completion date for this work. The localities of the country which have never been investigated; the nature of the bottom in sounding areas; the more or less favorable seasons or circumstances; and the means in operators, instruments, and accessories that may be disposable are critical influencing factors not allowing one to estimate otherwise except for giving detail parts.

Encouragement was given the resumption of work in a letter to Professor Hassler by former President James Madison:—"I am glad to learn that you are to resume the important labor of Survey in the Coast. I hope you will be able to complete it, and to your satisfaction, in which case I doubt not it will be to the satisfaction of those who invite you to the undertaking." (February 22, 1832)

To contain all that is needed for the defense of the coast in case of attack, the



West Base camp, 1837 — one of the principal stations in the original primary triangulation executed by Hassler in 1837—1840.

Southwesterly view from Harrow, N.Y., 1838, with Hassler's carriage and Great Theodolite, approaching the hilltop station.

Survey of the Coast was projected landward to include waterways formed by the mountains bordering the valleys emptying their waters into the sea. Hassler also pointed out that the work should furnish the elements of any other survey that may be desired for a variety of public needs. Accuracy of the work, when properly executed, rendered it fit to become a standard to which other surveys may be attached. The work thus obtained the necessary degree of accuracy for any public undertaking of general utility to the country.

Hassler's own devotion to duty was unquestionable. It spite of his age, he was not content to direct his projects from a desk. In extending the major triangulation over Connecticut, Hassler met nature head-on while taking observations on Bald Hill near Wilton, Conn. on July 24, 1833. As a violent thunderstorm approached, Hassler removed the telescope from the theodolite and secured it with bedding. But before he could return to the theodolite, the storm with hail and torrential rain became so severe that members of the survey party had to use their combined efforts to hold in place the tent sheltering the instrument. With great difficulty, Hassler and an assistant lifted the theodolite in the open hailstorm after the tent had blown away. In putting it down, Hassler's coat, billowed by wind, caught on the instrument and upset it. The repeating circle escaped damage, but three barometers were broken and all tents but one were blown away. Three days before the storm, Hassler had fallen on a rock, receiving injuries so severe as to affect his speech. The severe drenching and exertions to follow, handicapped him for a long time afterward.

The most time-consuming operation in the initial effort was the measurement of the base lines. Hassler's base line apparatus was, perhaps, the most original feature of his plan for the survey.

During the latter part of 1834, Hassler measured the first major baseline with the highest degree of accuracy obtainable; much greater, in fact, than the two baselines measured in 1817. At every 400 meters and 1,000 meters, strong pegs were driven in

Easterly view from Stony Hill, New Jersey, 1838.

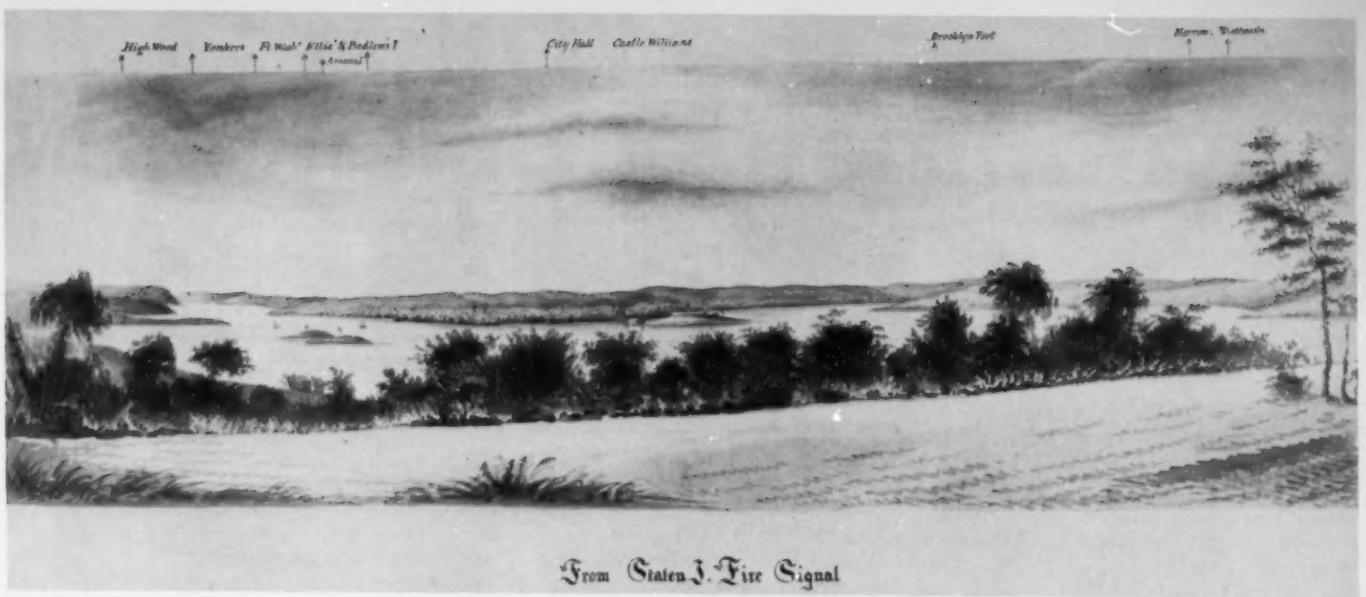
West Base station, above, showing the initial point of survey on Long Island, N.Y., and the survey camp of 1838.

the ground to mark their distance from the west end of the lines. At every 2,000 meters, stoneware cones were placed to make the points. Both ends of the base line rested on two sand knolls secured from the sea and marked by two monuments. The monuments consisted of a Newark red standstone, about 4 feet high, hewn square for about 18 inches from the top with a smooth top one foot square and a round hole in the center. Under the square cut, a frame was fixed in place, consisting of four pieces of hardwood, held closely by grooves chiseled in stone; the lower part was left rough. These stones were sunk entirely even with the sand, together with their frames which were extended about twenty inches on each side farther into the ground so as to make them solid, and maintain a perpendicular position. The distance between the monuments was about 8¾ miles. This operation required 45 days to complete.

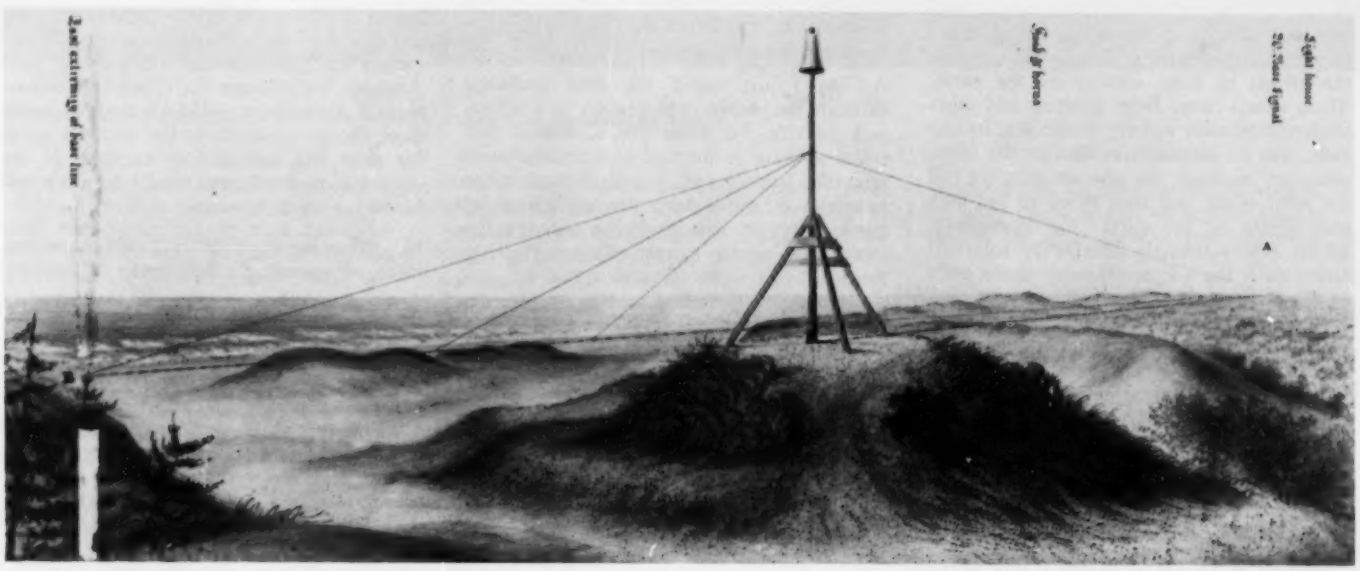
It was painstaking and time-consuming work—some thought it too time-consuming. In the early 1840's Hassler again began facing critics of his work. Was he taking too much time? Was too much money being spent to compensate him and his assistants? Was it possible that even his methods were not the best and a chronometric system might be more useful?

Hassler's problems multiplied and he had various occasions to invoke his abiding motto: "Difficulties never subdued me in my life." In these dark hours, he never departed from his great purpose in life. At the height of the controversy, a committee, headed by Lt. Col. John J. Abert, of the Topographical Bureau, defended the work of Hassler and his associates. As an old West Point friend of the Superintendent, who had worked on the Survey in 1816-1818, he supplied an enlightened insight into the character of a genius much in advance of his place in history. Tribute was paid Hassler for his industry, his knowledge of business, and his enthusiastic devotion to the prosecution and success of the work, not to be equaled in his life.

A portion of Hassler's ambitious nature perhaps was passed down to his son, provid-



Northeast view from the Staten Island Fire Station, 1838.



East Base of the original permanent base line laid out on Staten Island to initiate the primary arc of triangulation in 1839.

ing a tragic sidelight to the annals of the Coast Survey. In addition to surveying the coast, Hassler was also occupied with the supervision of weights and measures. In this capacity, he laid the groundwork for the present National Bureau of Standards. His son, Edward Troughton Hassler, acted for his father as head of the Weights and Measures Office. This office provided pertinent standards to the various custom houses and state governments. Hassler died on November 20, 1843, and on December 12, 1843, President Tyler appointed Alexander Dallas Bache to the dual post. Bache immediately recruited his long-term friend, Joseph Saxton, who was also to become a Coast and Geodetic Survey pioneer personality, to serve as head of the Weights and Measures Office. Edward Hassler was offered the assignment of second in charge to Saxton; he had aspired to become his father's successor. He refused the offer and resigned. He went to New York to visit members of his family and there on June 14, 1844, ended his life in a New York hotel room.

A survey of the coast, now as then, remains a duty which requires the exercise of the highest functions of mathematical knowledge, and the utmost skill in geodetic science, astronomy, gravity, and related fields. Once executed, it must endure for many decades, must be well financed, and must be extended in keeping with advancing civilization.

Hassler's workshop, both field and office, was the only school in those early years in which selected individuals, with proper educational backgrounds could be found.

When Professor Hassler was buried at Laurel Hill, near Philadelphia, a scroll was placed on the casket, reading in part: "His scientific writings and the national works created by him for the United States serve not only as beautiful memorials of his active life but for the education and enlightenment of mankind."

His memory now lives mostly in the National Ocean Survey. The Nation, most of whose people never will know his name, owes him a debt of gratitude.

Data For The "Other" Environmental Sciences

Alan H. Shapley, Director of the National Geophysical and Solar-Terrestrial Data Center, Environmental Data Service was interviewed By Jerry Coffman

Q. NGSDC has a long and complicated name. What is solar-terrestrial science? What is geophysics? Why are they treated together in a single center?

A. I'll answer the last part first. Each of the two fields is relatively small. Also, they overlap in subject matter. That is why they are treated together in a single center. Solar-terrestrial science, or we often say solar-terrestrial physics, is the collection of scientific disciplines and studies which involve the effects of solar activity on the earth. These effects range from sunspots and other evidences of solar activity on the sun, its surface, and its atmosphere; then to the interplanetary medium, the phenomenon we call the solar wind; and then down to the high atmosphere of the earth, the ionosphere, which is very strongly affected by solar activity, as is the magnetosphere—those parts of the earth's atmosphere from 50 miles upwards. Geophysics, on the other hand, comprises those sciences connected with the earth as a solid body. It includes seismology, gravity, the main magnetic field of the Earth, and related topics. These two fields have geomagnetism as an overlapping aspect.

Q. Are you a center for NOAA data, national data, or world data?

A. All of these. We serve the needs of U.S. users. In our fields, the expressed needs of our users, judged from inquiries, are satisfied with data collected originally by NOAA (about 5%), by other U.S. agencies, universities, etc. (about 35%), and by foreign organizations (about 60%). U.S. users mainly want solid earth and solar-terrestrial physics data for the globe as a whole.

Q. NGSDC operates world data centers for solar-terrestrial physics and for solid earth geophysics. How does this operation relate to the national data center?

A. World data centers collect data and information from countries around the world. These collections are made under informal, international agreements—agreements within scientific organizations. The WDCs do not—cannot, really—insist on cooperation in this data exchange. It's voluntary. However, we do get this cooperation—the system works. The national data collections, on the other hand, are generally much more detailed than the world collections, and the funding agencies often and rightfully insist that the data taken under their auspices be sent to a national center. So the data center can obtain the data and make them available to other users. In practice, the two collections are merged and are treated by the same experts.

Q. NGSDC seems to be strongly involved in international activities. What advantage does this have for the center?

A. As I just noted, the data exchange through the world data centers is a voluntary activity. To make this a success, our scientists have to interact with international scientific leaders and scientists from other countries to show them the advantages of participating in data exchange through the world data center system. To be effective, much of this work is carried out by personal contact, including service on international committees. Further, in our role as a World Data Center (actually there are three WDCs in most disciplines in different parts of the world, each with the same core data collection) we have users in other countries —last year in 60 different countries. These are a few of the reasons why we have to be active in international affairs in order that we can better serve the users of our data.

Q. Who are your customers?

A. About 6,000 different organizations and individuals request data from our center each year. It varies among the disciplines, but as a rough figure, one-fourth of our users are from universities, another quarter from the private sector, another 25% from foreign organizations and individuals, and the remaining 25% are U.S. government laboratories and agencies.

Q. How does NGSDC relate to other EDS centers?

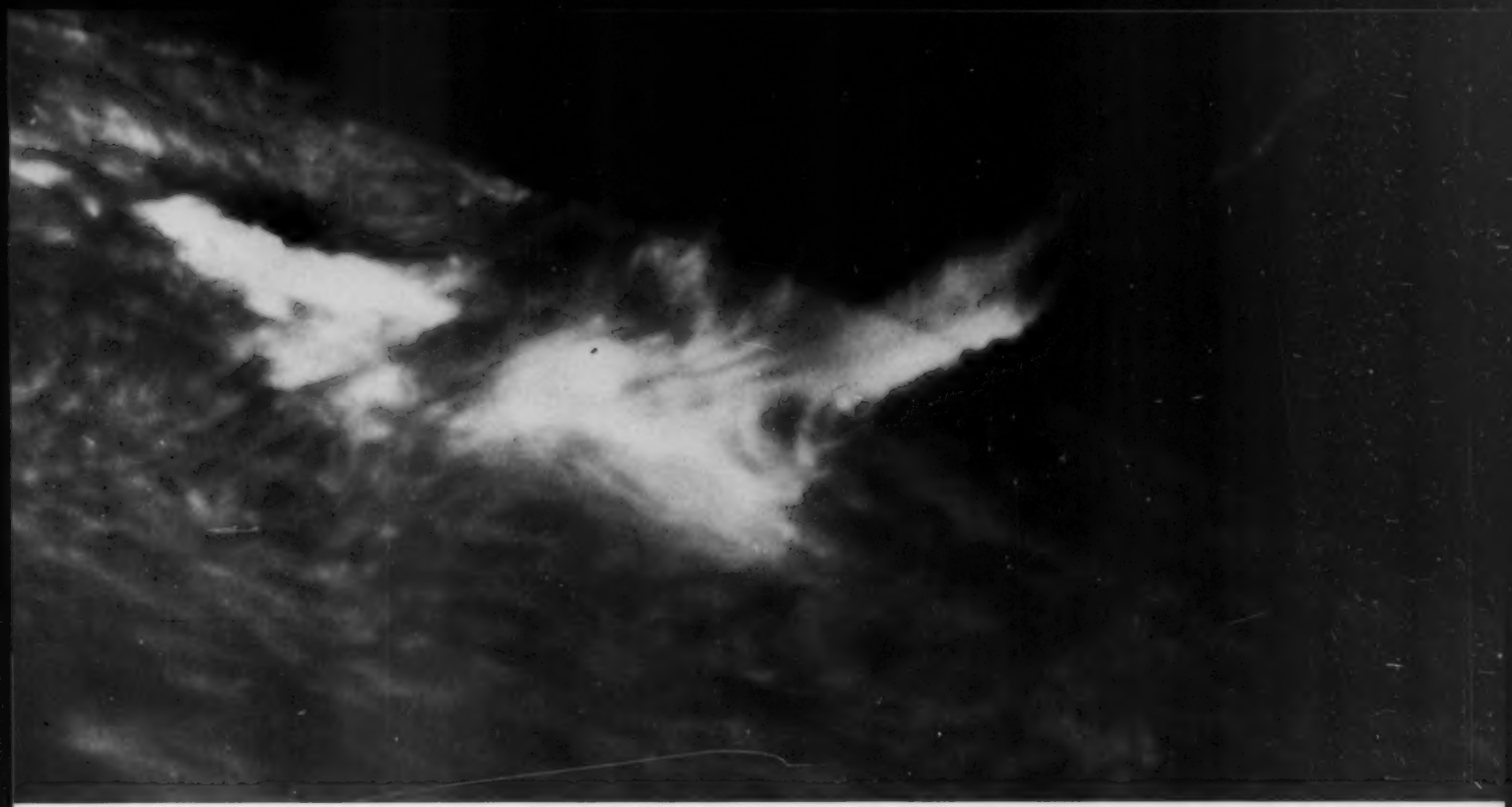
A. We are one of the three storage and dissemination centers under the Environmental Data Service. For data purposes, NOAA divides the environmental sciences into three divisions. One is meteorology, the responsibility of the National Climatic Center in Asheville, N.C.; the second is the fluid ocean, served by the National Oceanographic Data Center in Washington, D.C.; and the third is NGSDC, which is responsible for the solid earth and solar-terrestrial sciences. These three centers interact on data management problems and on any data requests which overlap our respective fields of concern. We share our data handling expertise and sometimes our specialized facilities. We try to have our data management systems compatible. We also gain from being closely linked to the other EDS centers—the Environmental Sciences Information Center, Center for Experimental Design and Data Analysis, and Center for Climatic Environmental Assessment. NOAA's unified, multidisciplinary approach to the national needs for data and information handling in the environmental sciences results in more and better service to all users.

Q. What are the problems, and the advantages, of operating a data center in Boulder?

A. One problem is that we are 2,000 miles from EDS headquarters in Washington, D. C., and must still interact with many of the other NOAA organizations and Federal agencies. The chief advantage is that we are established here in Boulder in the midst of a very large and stimulating scientific community working in the same fields in which we are operating. Our staff actively interacts with research workers in the disciplines we serve, and there is a mutual stimulation. We get many drop-in scientific visits.

Q. There appears to be a growing need to collect and process multi-disciplinary data and to provide data products for nonspecialists. How does this affect a disciplinary data center such as NGSDC?

A. In the first place, our center copes with many of the classical disciplines, so we have been a multidisciplinary center from the beginning. On the other hand, we are active, and need to be active, in providing multidisciplinary data services in such areas as sun-weather relationships, where we overlap with meteorologists, and in marine geology and geophysics, where we overlap with oceanographers. We try to have staff members who are familiar with these other disciplines. With regard to data products for nonspecialists, we have to provide these all the time. Within solar-terrestrial physics, for



Solar flares: data on their effects are collected from throughout the world by NGSDC.

example, an expert on the aurora or northern lights usually is not an expert on geomagnetic data, even though these two fields concern the same part of the atmosphere. Many of our users are engineers or lay persons. We must be careful not to mislead them with overly scientific data products. We must always be sure that our products are understandable and are interpreted for nonspecialists.

Q. How do you make users aware of the data services you provide?

A. We like to think that we are quite active, and effective, in "marketing." Compile users' catalogs (rather than archivists' catalogs) of our data holdings. We also distribute short, explanatory, plain-English notices of new data that we have, or of old data on hand. We distribute these fliers by mail and at scientific or technical gatherings. When appropriate, we put notices in technical journals. Also provide interviews like this one for the readers of NOAA Magazine.

Q. How do you decide what data to service?

A. In some cases the data services are planned in advance. For example, before the International Geophysical Year, the organizers decided what data should be archived and distributed from that huge collection activity. It is somewhat the same with the coming Geodynamics Program or the International Magnetospheric Study. Data services for these activities are planned in advance to a greater or lesser extent. Beyond that, though, we rely on requests from users, either in writing or made verbally at scientific meetings. Then we use our judgment as to how much efforts to put into any new data service. We try to be responsive to our users' needs.

Q. How does NGSDC relate to national problem areas, such as energy?

A. In several ways. We have the national archives of geophysical and geological data in offshore areas where exploration for oil and gas is underway. We get very involved in providing data both to government agencies and the private sector for energy-related problems. We are beginning to be active in maintaining an inventory and data bank on geothermal energy areas where there is a significant flow of heat from the earth's interior. These data, in turn, are used by those who are studying the geothermal energy problem. We get many inquiries from people interested in solar energy, but the kind of solar energy data that we archive here are not germane to such things as solar heating installations.

Q. What is NGSDC's role in the outer continental shelf programs in Alaska and elsewhere?

A. NGSDC is the archive for the government's programs to obtain baseline data in marine geology and geophysics for the outer continental shelf (OCS) areas. This is a huge program, funded by the Bureau of Land Management, and will result in large quantities of data which ultimately will be archived in our center and made available to users in the public and private sectors. To a lesser extent so far, we are involved in programs for other parts of the continental shelf.

Q. What role will NGSDC have in the International Magnetospheric Study?

A. The IMS is a sizeable international program, scheduled for 1976 to 1979 or so, to study the very outer reaches of the earth's atmosphere, primarily by coordinated satellite observations but supplemented by specific ground base measurements. We will be responsible, as World Data Center-A in conjunction with our sister WDCs, for the special ground base measurements made for the IMS, and in particular for the many new modern digital geomagnetc stations which will be placed in close-spaced networks in the higher latitudes. From the IMS, we will get a much greater quantity of digital magnetic tapes than before, by a factor of a hundred. There will also be many other kinds of specialized data from the more than 600 individual IMS projects. We will be responsible for processing these data, preparing data products and disseminating them to our users. Most of the onboard satellite data will be handled by the NASA Space Science Data Center, with which we cooperate very closely.

Q. What role will NGSDC have in the International Geodynamics Program?

A. This is a program somewhat analogous to the IMS but in the solid earth sciences, which has as its primary objective studies necessary to verify and improve on the

Feb. 1971 – California earthquake – Los Angeles Olive View Medical Center.

theory of plate tectonics. Here, the observational programs are not quite as well spelled out, and our role will be more as an information center, documenting who has taken what data, as well as where and when they were taken, and sharing this information with other participants in the geodynamics program. Many of our normal data services will also directly support the IGP.

Q. I understand that NGSDC has an active program in assisting ionosonde observatories around the world as part of a cooperative network. What assistance do you offer these stations and what do you get in return?

A. The assistance varies a great deal. We have loaned ionospheric radar equipment to about 40 different institutions which make observations at key, and usually remote, geographical locations. We have supplied some of these with film and spare parts and, in return, they share their resulting observations.

Q. One of the problems facing data centers is how to cope with new kinds of data, particularly high-sample rate digital data. How will this affect NGSDC, and what is NGSDC doing to meet this problem?

A. Until quite recently, the center's holdings were mostly in the form of sheets of paper and rolls of 35-millimeter film. In recent years, we have done some digitizing of analog records and otherwise compiled data in computer formats. Even now this represents only about 20% of our effort. There are several major, sizeable data-taking programs essentially upon us, in which the volume of data and the sampling rate in digital form on magnetic tape is a thousand times more than we have been coping with. So this will have, and is having, a dramatic effect on our operation. The end result of this is that in the next 5 years, the amount of our effort going into handling data in computerized form will skyrocket from 20% to perhaps 80%. We are trying to get the computer power and manpower to be ready to meet these challenges.

Q. One sometimes hears that geophysical data are used mainly for esoteric research. Is this so?

A. I would object to the word *mainly*. Our data are used for research into the frontiers of man's knowledge; they also are used for many down-to-earth, practical applications. One of our sizeable user categories includes surveyors, lawyers, and insurance people who want to know what the direction of the earth's shifting magnetic field was 20 years ago, or one hundred years ago, to settle land disputes arising because the tracts were originally described in terms of magnetic bearings. Remember I said earlier that 25% of our users are from the private and industrial sector. The oil companies, the telecommunications people, the government laboratories—they wouldn't call their research and applications "esoteric".

Q. What can be done to assure that important data sets are not lost when the programs of mission-oriented agencies will no longer support them?

A. This is one of the major reasons for the creation of the Environmental Data Service. We know have within the Federal Government a mission-oriented agency whose *mission* is to provide data services. We try to be alert to and aware of what is going on in other mission-oriented, data-gathering agencies, and for that matter in universities and private groups, so that when their interests change or they lose support for their programs, their data are turned over to the appropriate EDS Center. And we have to make our existence well enough known so that the organizations involved will themselves take the initiative and get in touch with us. We have acquired quite a number of important data sets in this manner.

Q. Other agencies support an appreciable part of NGSDC programs. What are some of the areas? Are these activities of use to other users of NGSDC data?

A. Support from other agencies usually comes about when a data need of interest to that agency arises and NGSDC does not have the resources to suddenly, fully satisfy the need. In these cases we try to arrange with the agency to share the support of a national data program in that area until we can build up our own resources to provide full support. An important area where this has occurred is the providing of microfilms of seismograms from a large 115-station network, originally sponsored by the Advanced Research Projects Agency (ARPA) and more recently by the National Science Foundation and the U.S. Geological Survey. We are in the process of phasing out the NSF support for microfilming these data. Another example are the data resulting from U.S. activities in the International Decade of Ocean Exploration program (IDOE) where, again, the NSF gave invaluable support to get the data activity going. We are hoping to gradually phase out their support here also. In answer to the last part of your question, Amen! The users of the data services supported in part by other agencies include not only those agencies, but more importantly, include the whole user community concerned with the area.

Q. NGSDC has an active guest worker program. How does it work?

A. Most of our data services are conducted by mail. Somebody calls up, writes us a letter, or sends us a telegram and we provide them with the data or the data product. We

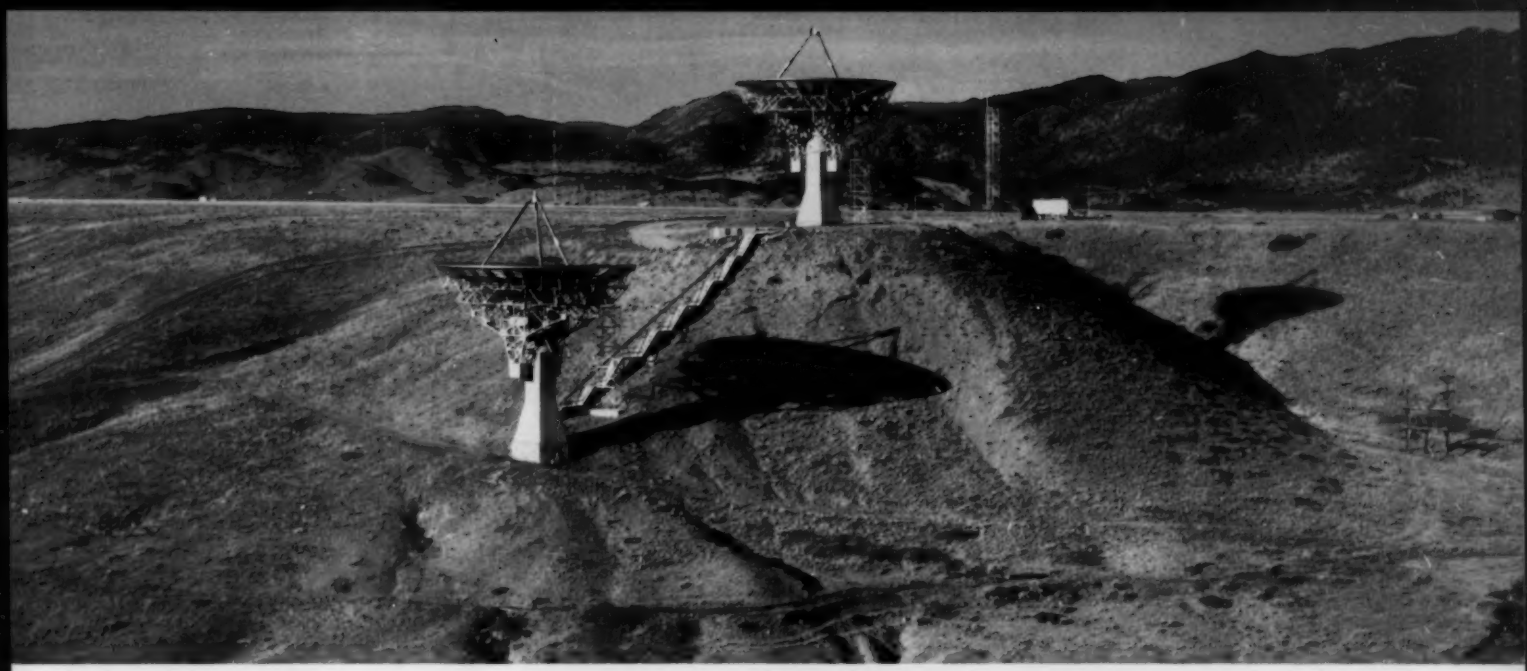


Table Mountain, six miles north of Boulder, 60-foot parabolic antennas used for radio propagation experiments in the troposphere.

provide other types of services such as helping to select data for a particular problem or to make interpretations and assessments. But just as in a library, a very efficient way of using the collection is for the scientist or the engineer to come to the center and work with the collection—browsing and conducting his data-related research right on the premises. We encourage this, and provide office space and nominal facilities and assistance to such visiting scientists. At this moment, I believe we have 11 such guest workers. Some of them are Americans. We have a scientist from Australia, one from India, another from Japan. This is typical of the way this program operates, and we think it is a very effective way of making our data services available. And it keeps our staff on their toes.

Q. What long-term goals do you have for NGSDC?

A. In a broad sense, our main goal is to provide service, and adequate service to the whole gamut of users. But more specifically, I would hope that over a period of time we can assemble a much improved comprehensive inventory of what data exists in our fields, whether it is in our archives or somewhere else. This inventory would be shared with our users and we would help them gain more effective access to the data they need. Secondly, I want us to become as nearly an omniscient switching center for data information as is humanly possible. We must develop the capability to cope with the higher volume of data I discussed earlier, so there will not be a trend to set up new data centers specifically for that purpose, which will, unavoidably, at least partially duplicate our efforts. Finally, over the years, I want to improve technical expertise in all of our fields. As I said before, we are involved in many different scientific disciplines in the classical sense of the word. We need to increase the capabilities of the staff for our more standard services, but also so we can do a much better job in data evaluation, data quality control, and most importantly, data assessment, to serve those coping with national technological and scientific problems. We have made a start towards each of these goals but we have a long way to go. In the meantime we are pleased we seem to have so many apparently satisfied "customers" for our data services. Their requests challenge us every day.

Alan H. Shapley is Director of the National Geophysical and Solar-Terrestrial Data Center located in Boulder, Colorado. NGSDC was created from the Aeronomy and Space Data Center, located in Boulder since 1957, and the National Geophysical Data Center, which was transferred from the Washington, D. C., area to Boulder in 1971. NGSDC combines in one center NOAA's data activities in seismology, geomagnetism, marine geology and geophysics, solar activity, interplanetary phenomena, the ionosphere, cosmic rays, aurorae, and airglow.

Mr. Shapley graduated from Harvard University in 1940, where he majored in Astronomy. His graduate studies at the University College of Wales in Aberystwyth were in physics. During the years 1942 to 1946, Mr. Shapley helped develop the radio propagation forecasting activities at the Carnegie Institution of Washington. After the war, he shifted to the National Bureau of Standards Central Radio Propagation Laboratory where he directed solar-terrestrial research studies and the forecasting work for several years. In 1952, he became involved in the planning for the International Geophysical Year 1957-58, his primary interest for the next 10 years. He was Vice-Chairman of the U.S. IGY program coordinated by the National Academy of Sciences as well as a member of the international IGY committee.

In the mid-1960's Mr. Shapley served on one of the working groups which laid the groundwork for the formation of ESSA, the predecessor of NOAA, and then for a period of about 5 years, was director of the Office of Programs of the Environmental Research Laboratories in Boulder. Mr. Shapley has authored many scientific papers, largely in the ionospheric field, including a detailed study of the Antarctic ionosphere. Based on the work he started at Aberystwyth, Mr. Shapley published some of the early papers on stratospheric-ionospheric interactions. This was the genesis of his interest in the interrelationships of meteorology and solarterrestrial physics. He recently coauthored an NGSDC bibliography for this interdisciplinary field.

The problems of fun on the water

Focus: Marine Recreation

BY RAYMOND WILCOVE

Recommendations will be presented soon to NOAA on the role it can play in advancing the use of the nation's coastal areas for marine recreational activities.

The recommendations will incorporate the views expressed by experts in the field from the United States and Canada at the first national conference on marine recreation held at Newport Beach, Calif., Oct. 2-4.

They were drafted by officials of NOAA and those of the University of Southern California Sea Grant Institutional Program, which cosponsored the conference.

"Our report will attempt to embody as best we can the views expressed at the conference by some of the most knowledgeable people in the field on the best utilization of our dwindling coastal resources," said Philip M. Roedel, NOAA's Coordinator of Marine Recreation Programs, who chaired the event.

"The conference represented a major effort to marshal the best thinking possible on how our coastal areas—probably our greatest natural resource, for marine recreation—can best be used for the benefit of the greatest number," Roedel added. "Out of it, we hope, will come some positive steps that will help reconcile the conflicting views of different segments of the population on the use of this terribly important, but so far largely ignored, natural asset."

Roedel will present his report to Dr. Robert M. White, NOAA Administrator, who outlined the purpose of the gathering at its opening session.

"We want the conference to recommend policies and actions to improve recreational uses of coastal resources," White told the more than 250 participants—resource planners and managers, business executives, recreation specialists, elected officials, scientists, educators and industrialists.

"Coastal areas are in high demand for both recreational and non-recreational uses. As development pressures mount, recreational opportunities are often diminished unless critical planning and management decisions are made early. This conference should address the issues that both the public and the private sectors must face in arriving at such decisions."

During the meetings, a series of workshops led by invited panelists discussed the allocation of marine resources for recreational use, environmental considerations, research and education needs, the application of marine science and technology to increase the recreational use of marine resources, and social, economic and legal questions involved in the recreational use of the coastal environment.

Specific issues under each of these general topics were analyzed and evaluated and conferees made recommendations for both government and private actions to enhance the recreational potential of estuaries, coastlines, nearshore waters and coastal islands. However, no formal recommendations were made to NOAA and it was left to the coordinators to evaluate them for presentation to Dr. White for his consideration.

The conference brought together for the first time on such a scale authorities on coastal planning, resources and utilization from throughout the United States and Canada. Participants included such diverse personalities as John R. Hubbard, President of the University of Southern California; George Rounds, Executive Director, National Association of Engine and Boat Manufacturers; Michael J. McCloskey, President, Sierra Club; Robert W. Knecht, NOAA's Assistant Administrator for Coastal Zone Management; and Byron J. Washom, Massachusetts Institute of Technology.

Others were Matt G. Kaufman, Administrator, Boating Industry Association; Frank E. Carlton, President, National Coalition for Marine Conservation; Michael R. Krouse, Institute for Water Resources, Army Corps of Engineers; Rimmon C. Fay, President, Pacific Bio-Marine Supply Co.; Philip A. Meyer, Chief, Economic and Management Planning of Environment Canada's Fisheries Division; Charles Odegaard, Director, Washington Parks and Recreation Commission; Francis Williams, Chairman, Division of Biology and Living Resources, Rosenstiel School of Marine and Atmospheric Sciences; and Richard H. Stroud, Executive Director, Sport Fishing Institute.

In the two and a half days the talks continued, many conflicting views were presented, but on one point the conferees were in agreement—the urgency with which coastal zone problems had to be met if there were to be any successful solutions.

Keith Ozmore, Environmental Assistant to Congressman Bob Eckhardt of Texas, pinpointed the need for action. This year, he stated, of an estimated 214 million population in the United States, 178 million (83 percent) is living in coastal states and in 10 years, almost 202 million of an estimated 240 million will be living there. Of the latter, almost 45 percent will be living in coastal counties. Francis H. Dean, an environmental planner and landscape architect, put it another way: eighty percent of the nation's population lives within an hour's drive of the coastal region.

But while the coasts are within reach of most of the population, various speakers pointed out that the areas to which they can go for recreation are limited and growing constantly less. Consulting engineer John B. McAleer said flatly that "there are not enough beaches to meet public demand.

"Only about one-third of the national shoreline has beach areas," he said, "and of these 70 percent is privately owned and not available for public use." Furthermore, he added, many beaches are shrinking, due to continuing erosion, and "most of the best beaches are located away from the major population areas where people most need public beaches."

The voices that spoke at the conference often reflected the conflicting interests of the speakers—the commercial fishermen versus the sport fishermen, the petroleum engineers versus the environmentalists, the builders versus those who would reserve the beaches for use by the general public, the recreational boaters versus the swimmers.

Janet K. Adams, president and executive director of the California Coastal Alliance which spearheaded the drive in 1972 for the adoption by petition of the California Coastal Zone Conservation Act, pleaded with opponents to get together to solve the burgeoning problems that afflict the coastal areas.

"The same energies that created environmental controls and fought the creation of environmental controls must be channeled into working together for environmental solutions," she stated.

Philip A. Mayer, a Canadian environ-

At well-attended recreation conference (above), conferees were addressed by Philip Roedel, NOAA's Coordinator of Marine Recreation Programs (below, left) and at keynote session (below, right), Don Walsh, Director, Institute of Marine and Coastal Studies (1.) and John Hubbard, President, University of Southern California, and Dr. Robert M. White, NOAA Administrator.

mental official, said it all boiled down to "a question of emphasis . . . a determination of thrust and focus." He asked: "Will we be able to so govern the use of our marine areas and foreshore that the quality of our recreational experiences will be preserved, that their benefits will be widely distributed?"

John S. Gottschalk, executive vice president of the International Association of Game, Fish and Conservation Commissioners, warned the conference that "we're dealing with a finite resource where it is only a question of time before it can not meet the needs of the American public." He added: "It is not just part of life that we are talking about, but the essence of a way of life that's at issue here."

Despite this, he added, perhaps because of the American work ethic, there is a tendency in high places, especially in the government, not to take recreation seriously. "Too many think you're goofing off when you do," he said.

Dr. White had laid out the problems that the conferees addressed themselves to, and the need for a marine recreation policy focus, in his keynote address. "While the energy and food resources of the seas have been justifiably at the center of our attention in recent years, the time has come to focus on making sure that marine recreation, one of the most important uses of the seas, is given its proper due," he said.

"Until now there has been an absence of a focus for examining our national policy on marine recreation," he stated. "The field has been considered as an aspect of outdoor recreation, which it is. It has been dealt with by many different groups in terms of recreational fishing or recreational boating, water safety and many others.

"We believe the time has come," the NOAA Administrator added, "to look at the problem in a more comprehensive way to ensure that opportunities for marine recreation are preserved and enhanced. The National Oceanic and Atmospheric Administration is prepared to offer a focus to accomplish this . . ."

White stressed that NOAA is now responsible through various legislative enactments, such as the Coastal Zone Management Act of 1972, for key programs that can establish "the basic framework for our entire national marine recreational effort." But he added that no one federal agency acting alone "can bring about the achievement of broadened marine recreational opportunities." Other federal agencies are deeply involved, he pointed out, including the Interior Department with its general responsibility for outdoor recreation.

White emphasized also the important roles that can be played in this area by state and local bodies. "Our commitment is to the maintenance of state or local prerogative," he stated.

Speaker after speaker stressed the importance of recreation to a healthy body politic. Susan H. Anderson, coordinator of the conference for the University of Southern California, said "recreation is an important part of our lives, affecting individual physical well being, releasing tensions, and enriching us through relaxation and satisfaction."

Perhaps John Masefield, the British poet laureate, said it for all of us years ago, when he wrote:

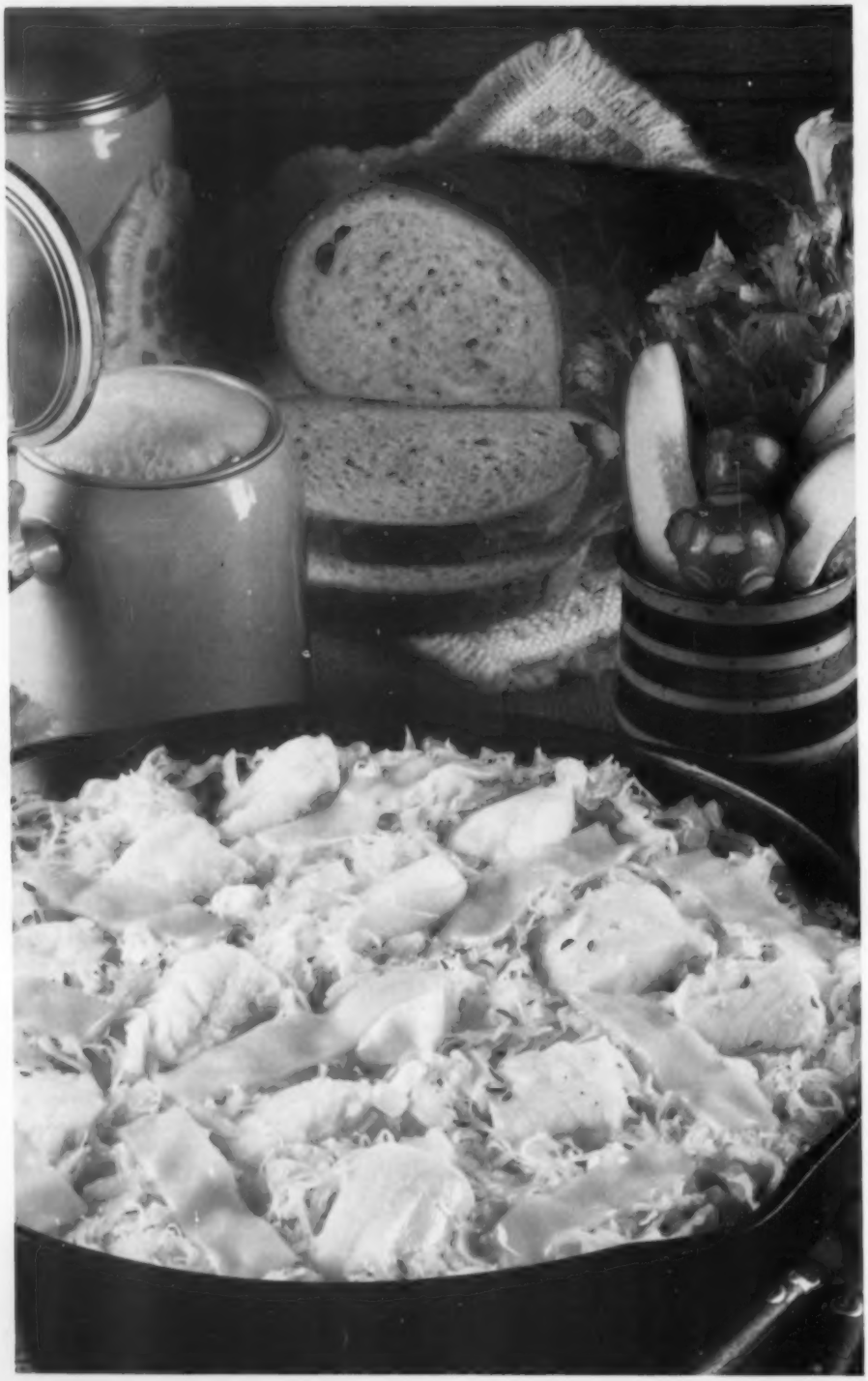
> "I must go down to the sea again,
> To the lonely sea and the sky."

Or Francis H. Dean, the environmental planner, who, alluding to man's beginnings said the coastal region was "an area of mysterious magnetism which casts a spell over all of us, perhaps related in some way to our finlike origin."

Proceedings of the conference will be available, probably in April, for non-participants for $10 from the Sea Grant Program, University of Southern California, University Park, Los Angeles Calif. 90007.

Sea Fare

Seafood: Waste-free and tasty



Most homemakers today have to save time in meal preparation as well as having to watch the food budget closely. Is this your challenge at the moment? Don't worry—you don't have to short your family when it comes to easily prepared meals. Plan ahead, don't buy more than you need and can use, and avoid impulse buying. Planning, selecting, and preparing are the three most important parts of staying within a food budget.

Family nutritional needs can be met without straining the budget. All you need is a sprinkle of imagination and a selection of high-protein, moderate-cost fishery products. Have you considered the fact that when you buy fish fillets, canned seafood, or fish sticks and portions, you are getting one-hundred percent food? There are no throwaway bones or fat to trim, just lean, protein-rich meat, and these versatile products are so adaptable that they may be enjoyed as the main entree or combined with rice, potatoes, or one of the many varieties of pasta to help satisfy hungry appetites.

Take that sprinkle of imagination and enjoy fish with these tasty, easy on the budget recipes.

Cheesy Fish And Sauerkraut Skillet

1 pound fish fillets, fresh or frozen
½ cup chopped onion
2 tablespoons margarine or cooking oil
1 can (1 pound 11 ounce) sauerkraut, well drained
½ cup water
½ teaspoon caraway seed
½ teaspoon garlic salt
1 package (3 ounce) cream cheese, cubed
2 slices process American cheese, cut in strips

Thaw frozen fish; cut into 1-inch pieces. Cook onion in margarine or oil in 10-inch frypan until tender, but not brown. Add sauerkraut, water, caraway seed, and garlic salt. Cover and simmer about 30 minutes or until flavors are well blended. Stir cream cheese into sauerkraut. Top with fish pieces. Cover and simmer about 10 minutes or until fish flakes easily when tested with a fork. Top fish with strips of cheese; allow to melt. Makes 4 servings.

Crusty Salmon Croquettes

1 can (1 pound) salmon
½ cup chopped onion
2 tablespoons melted margarine or cooking oil
2 tablespoons flour
½ cup milk
2 cups cooked rice
1 egg, beaten
½ cup grated cheese
½ teaspoon salt
Dash pepper
1 cup cereal crumbs
¼ cup cooking oil
6 spiced apple rings
Chopped parsley

Drain and flake salmon. Cook onion in melted margarine or cooking oil until tender. Blend in flour. Add milk gradually and cook until thick, stirring constantly. Add rice, egg, cheese, salt, pepper, and salmon. Chill several hours. Shape into 6 cones. Roll in crumbs. Place cones on a well-greased baking pan, 15 by 10 by 1 inches. Pour cooking oil over cones. Bake in an extremely hot oven, 500° F., for 10 to 15 minutes or until lightly brown. Remove from oven and place spiced apple rings on baking pan. Bake 4 to 5 minutes longer or until apples are heated. Arrange croquettes and apple rings on warm serving platter. Sprinkle with parsley. Makes 6 servings.

Tuna-Egg Bake

1 can (6-½ or 7 ounce) tuna
6 tablespoons butter or margarine
¼ cup flour
1 teaspoon salt
Dash peper
1-½ cups milk
1 can (4 ounce) sliced mushrooms (undrained)
1 tablespoon Worcestershire sauce
4 hard-cooked eggs, sliced
1 cup shredded process American cheese
1 cup torn soft bread crumbs
6 thin tomato slices* (optional)

Drain and flake tuna. Melt ¼ cup (4 tablespoons) butte. or margarine. Stir in flour, salt, and pepper. Add milk; cook, stirring constantly, until thichened. Stir in undrained mushrooms and Worcestershire sauce. Carefully fold in tuna, sliced eggs, and ½ of the cheese. Melt remaining 2 tablespoons butter or margarine; add bread crumbs and toss lightly to coat bread evenly. Stir in remaining cheese. Spoon ½ of the tuna mixture into shallow 1-½ quart baking dish; sprinkle with ½ of the crumb mixture. Top with remaining tuna mixture and sprinkle remaining crumb mixture around edge of dish. Bake in moderate oven, 375° F., about 25 to 28 minutes or until tuna mixture is hot and bubbly. Makes 6 servings.

*If desired, remove baking dish from oven after 20 minutes, arrange tomato slices down center of dish. Return to oven about 5 to 8 minutes or until tomato slices are heated and tuna mixture is hot and bubbly.

Seafood Stroganoff

12 frozen, pre-cooked, breaded fish portions (2-½ or 3 ounces each)
2 tablespoons melted fat or oil
Paprika
2 tablespoons butter or margarine
1 teaspoon poppy seeds (optional)
2 cups hot cooked egg noodles
Stroganoff Sauce
Chopped parsley

Place frozen fish portions on a well-greased cooky sheet, 15 by 12 inches. Drizzle fat over fish. Sprinkle with paprika. Bake in an extremely hot oven, 500° F., for 10 to 12 minutes or as directed on package. Add butter and poppy seeds to noodles. Arrange noodles on a platter and place portions on top. Pour Stroganoff Sauce over portions. Sprinkle with parsley. Serves 6.

Stroganoff Sauce

1 can (4 ounces) sliced mushrooms, drained
½ cup chopped onion
1 clove garlic, finely chopped
2 tablespoons melted fat or oil
¼ teaspoon paprika
1 can (10½ ounces) condensed cream of chicken soup
¼ teaspoon salt
Dash pepper
1 cup sour cream

Cook mushrooms, onion, and garlic in fat until tender. Stir in paprika. Add soup and seasonings. Cook over low heat for about 10 minutes, stirring occasionally. Add sour cream; heat.

Fish Portion-Stroganoff Casserole

1 package (12 ounce) frozen, breaded fish portions
2 tablespoons melted margarine or cooking oil
1 tablespoon lemon juice
3 cups medium noodles (6 ounces), cooked and drained
1 can (8-½ ounce) peas and carrots, drained*
1 can (10-¾ ounce) condensed cream of chicken soup
½ cup dairy sour cream
½ cup milk
1 teaspoon Worcestershire sauce
½ teaspoon onion or garlic salt
Dash peper

Broil fish portions as directed on package label, drizzling margarine or oil and lemon juice over portions before broiling. Combine noodles, peas and carrots, soup, sour cream, milk, Worcestershire sauce, onion or garlic salt, and pepper; mix well. Pour into shallow 1-½ quart casserole. Top with fish portions. Bake in moderate oven, 350° F., 25 to 30 minutes or until noodle mixture is hot and bubbly. Makes 4 servings.

*One package (9 ounce) frozen peas and carrots, cooked, and drained, may be substituted for canned ones, if desired.

Tuna-Vegetable Loaf

2 cans (7 ounce each) tuna
2 cups (¼-inch) soft bread cubes
¾ cup milk
1 cup finely chopped celery
¼ cup finely chopped onion
4 eggs, beaten
1 tablespoon chopped parsley (optional)
1 tablespoon lemon juice
1 teaspoon salt
Mustard Sauce (recipe follows)

Drain and flake tuna. Grease an 8-½ by 4-½ by 2-5/8-inch loaf pan. Line bottom with aluminum foil and grease foil. Combine bread cubes and milk; heat just until mixture bubbles, stirring constantly. Remove from heat. Stir in celery, onion, and remaining ingredients, except Mustard Sauce. Pour tuna mixture into pan. Bake in slow oven, 325° F., about 1 hour or until mixture is set. Cool in pan 15 minutes before removing from pan. Slice and serve with warm Mustard Sauce. Makes 6 servings.

Mustard Sauce

½ cup salad dressing or mayonnaise
½ cup dairy sour cream
1 tablespoon prepared mustard
1 tablespoon lemon juice
½ teaspoon horseradish
1½ teaspoons grated lemon rind

Combine ingredients; mix. Heat slowly, stirring constantly, until desired serving temperature. Makes about 1 cup sauce.

Glorifried Flounder With Chives

2 pounds flounder or sole fillets, fresh or frozen
2 cups sour cream
¾ cups chopped chives (frozen) or
6 tablespoons dehydrated chopped chives
1 teaspoon salt
¼ teaspoon pepper
2 cups biscuit mix
Melted fat or oil for frying
Paprika

Thaw frozen fish fillets. Divide into serving size portions. Combine sour cream, chives, salt, and pepper. Reserve 6 tablespoons sour cream mixture for garnish. Dip flounder or sole fillets into sour cream mixture, then in biscuit mix; repeat. Fry in fat or oil 1/8 inch deep at 360° F., until both sides are brown and crisp. Garnish each serving with one tablespoon sour cream mixture; sprinkle with paprika. Makes 6 servings.

(Note: If frozen chives are not available, substitute 6 tablespoons dehydrated chopped chives. After mixing dehydrated chives with sour cream, let stand approximately 30 minutes to reconstitute chives.)

Smoky Sablefish Casserole

2 pounds smoked sablefish or other smoked fish
4 hard-cooked eggs
¼ cup butter or margarine
¼ cup flour
¼ teaspoon salt
¼ teaspoon white pepper
3-½ cups milk
1 quart hot cooked macaroni
1 cup shredded sharp cheddar cheese
1 can (4 ounces) sliced mushrooms, undrained
¼ cup sliced ripe olives
¼ cup chopped pimiento
1 cup soft bread crumbs
2 tablespoons melted butter or margarine
12 pitted ripe olives for garnish

Remove skin and bones from fish. Flake the fish. Slice eggs and reserve 12 slices for garnish. Chop remaining eggs. Melt butter in a 4-quart saucepan. Blend in flour and seasonings. Add milk gradually and cook until thick, stirring constantly. Combine all ingredients except egg slices, crumbs, butter, and olives. Place in a well-greased 3-quart casserole. Combine crumbs with remaining butter. Sprinkle over casserole. Bake in a moderate oven, 350° F., for 45 to 60 minutes or until hot and bubbling. Garnish with olives and egg slices. Makes 12 servings.

Note: This casserole may be prepared a day ahead and refrigerated. Allow about 30 minutes additional baking time.

Fish Stick Wrap-Ups

24 frozen fried fish sticks (¾ to 1-¼ ounces each)
6 slices (1 ounce each) pimiento cheese, cut into four strips
12 slices bacon

Top 12 frozen fish sticks with 2 strips of cheese. Cover with remaining 12 fish sticks. Wrap bacon lengthwise around sides of fish sticks to cover exposed edges of cheese. Secure with toothpicks. Cover broiler rack with heavy-duty aluminum foil. Cut 4 or 5 slits in foil to allow fat to drain during cooking. Place fish sticks on broiler rack. Broil about 4 inches from source of heat for 10 to 15 minutes or until bacon is crisp. Turn once during broiling. Makes 6 servings.

Red And White Seafood Roll-ups

2 pounds flounder fillets or other thin fillets, fresh or frozen
½ teaspoon salt
Salmon Stuffing
1 can (10-½ ounces) cream of celery soup
1 cup white wine
Dash Worcestershire sauce
⅓ cup grated cheddar cheese
Minced parsley
Pimiento strips

Thaw frozen fillets. Skin fillets. Cut into 12 portions. Place fish, skinned side up, on a cutting board. Sprinkle fish with salt. Divide salmon stuffing into 12 portions, about 1 tablespoon each. Place stuffing on fish. Roll fish around stuffing. Skewer or tie. Place fish rolls, stuffing side up, in a well-greased baking dish, 13 by 9 by 2 inches. Combine soup, wine, and Worcestershire sauce. Pour sauce over fish rolls. Bake in a moderate oven, 350° F., for 20 minutes. Baste with sauce in pan. Sprinkle with cheese. Bake 5 to 10 minutes longer or until cheese melts and fish flake easily when tested with a fork. Garnish with parsley and pimiento. Makes 6 servings.

Salmon Stuffing

1 can (7-¾ ounces) salmon
1 egg, beaten
1 teaspoon chopped parsley
½ teaspoon liquid hot pepper sauce
½ teaspoon onion powder
¼ teaspoon paprika

Drain and flake salmon. Combine all ingredients. Makes approximately ¾ cup stuffing.

noaa/update

Gold, Silver Medals

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Dr. Glahn

Dr. Collins

R.Adm. Nygren

Dr. Rasmussen

Mr. Moore

Dr. Noxon

Dr. Austin

NOAA employees received seven Gold Medal Awards and 18 Silver Medal Awards from Secretary of Commerce Rogers C.B. Morton in an honors award program.

Recipients of the Gold Medal, the Department's highest honor, bestowed for rare and outstanding contributions of major significance to the Department, the Nation, or the world, such as major contributions to science, technology, or administration; highly distinguished authorship; heroic action involving jeopardy of life; and demonstrated outstanding leadership in the administration of major programs, were:

Dr. Thomas S. Austin, Director of the Environmental Data Service, Washington, D.C., for his many years' service as a prime mover in developing national and international policies in marine science and environmental data management programs.

Dr. Gerald B. Collins, Division Director, Coastal Zone and Estuarine Studies at the National Marine Fisheries Service Northwest Fisheries Center in Seattle, Wash., for his major contribution to fishery science and administration.

Dr. Harry R. Glahn, Deputy Director of the Techniques Development Laboratory in the National Weather Service's Systems Development Office, in Silver Spring, Md., for his pioneering work in applying computer models to weather forecasts.

Dr. John F. Noxon, Chief of the Optical Aeronomy Program in the Environmental Research Laboratories' Aeronomy Laboratory, in Boulder, Colo., for outstanding contributions to atmospheric science by the creative use of optical spectroscopic techniques for measuring atmospheric composition and temperature.

R. Adm. Harley D. Nygren, Director of the NOAA Corps, for his sustained superior leadership for many years in areas of top level staff direction within NOAA and the Department of Commerce.

Dr. James L. Rasmussen, now Director of the U.S. Gate (Global Atmospheric Research Program Atlantic Tropical Experiment) Project Office in the World Weather Program Office in the Office of the Associate Administrator for Environmental Monitoring and Prediction, in Rockville, Md., primarily for outstanding achievement in GATE, the largest and most complex internation scientific experiment ever undertaken.

Spencer Bennett and Randolph Moore of the NWS Observing Station on Islas del Cisne (Swan Island), Honduras, for their heroic actions in the rescue of 19 shipwrecked fisherman in the Caribbean last December.

Silver Medals, awarded for contributions of unusual value to the Department, such as contributions to science, technology, or administration; outstanding skill or ability in the performance of duties which has resulted in program advancement; meritorious authorship; or unusual courage or competence in an emergency, were presented to:

Ben P. Barker, Jr., for his leadership in natural disaster warnings and community preparedness programs in Alabama and Oklahoma.

Capt. John O. Boyer for major contributions to the advancement of international cooperation in nautical charting and for outstanding leadership in citizen-government interrelations for safety at sea.

Dr. Robert W. Burpee, a Meteorologist at ERL's National Hurricane and Experimental Meteorology Laboratory in Miami, Fla., for his meritorious service as chief of the international group responsible for providing weather forecasting to GATE.

Arthur R. Cooke, Chief of the Telecommunications Management and Planning Division in the Office of Management and Computer Systems in the Office of the Assistant Administrator for Administration, for exceptional and outstanding leadership in coordinating environmental telecommunications planning among various Federal agencies.

Robert B. Doeker, for vision and leadership in the establishment of the first operational space weather forecasting service, the application of research information to service organizations, and the continuing development of international exchange of data.

W. John Hussey, Chief of the Field Services Division of the National Environmental Satellite Service, for exceptional skill in the implementation and management of the SMS/GOES (Synchronous Meterological Satellite/Geostationary Operational Environmental Satellite) satellite data utilization system.

Joseph R. Irwin, a Meteorologist in the Meteorological Techniques Branch of the Automation Division at the NWS National Meterological Center in Suitland, Md., for his key role in putting into effect a new automatic weather analysis and forecasting system.

Dr. Ray E. Jensen, Director of the NWS Environmental Studies Service Center (ESSC) at College Station, Tex., for the outstanding managerial skill he demonstrated in launching the Nation's first ESSC at Auburn University, Ala.

Russell G. McGrew, Chief of the AFOS (Automation of Field Operations and Services) Implementation Staff in the Office of the NWS Director, for his leadership in developing a plan for automating field operations of the NWS and for applying computer technology to weather radars.

N. Arthur Pore, Chief of the Marine Techniques Branch of the Techniques Development Laboratories in the NWS Systems Development Office, for his outstanding contributions to the science of weather forecasting in the marine environment.

John H. Robinson, for exceptional leadership demonstrated in the inauguration of NOAA's outer continental shelf assessment program in Alaska conducted for the Interior Department's Bureau of Land Management.

Laurence G. Shaffer, Emergency Warning Coordinator for the NWS Central Region, in Kansas City, Mo., for his lifesaving activities against killer storms and floods.

Dr. Carl J. Sindermann, Director of the NMFS Middle Atlantic Coastal Fisheries Center in Highlands, N.J., for outstanding leadership in administration of major ocean resource research projects.

Walter Telesetsky, now Director of the Program Integration Office in the Office of Environmental Monitoring and Prediction in Rockville, Md., for exceptional service to the Nation in planning, managing and coordinating U.S. participation in GATE.

Donald R. Whitman, now Chief of the Data Acquisition Division at the NWS Central Region Headquarters in Kansas City, Mo., for his outstanding performance in his previous position as Assistant Director for Meteorology and Management of the NWS Technical Training Center in Kansas City.

Group Award, for outstanding performance while serving as Chief Scientists aboard U.S. research vessels during GATE:

Dr. Kirby J. Hanson,
Dr. Peter L. Grose, and
Dr. James K. Sparkman.

Group Award, for outstanding achievement in furthering man's understanding of the role of the tropics in the Global Atmospheric Circulation to:

Robert F. Long,
Edward V. Tiernan,
Cdr. Sigmund R. Petersen, and
Capt. Richard H. Houlder.

And a Group Award to ten NWS hydrologists for their joint accomplishment in improving methods used to forecast rivers and floods in the United States:

Eric A. Anderson, Silver Spring, Md.; **Robert J.C. Burnash**, Sacramento, Calif.; **Robert L. Ferral**, Sacramento, Calif; **Donald W. Kuehl**, Portland, Oreg.; **John P. McCallister**, Gaithersburg, Md.; **John C. Monro**, Rockville, Md.; **Dr. Eugene L. Peck**, Vienna, Va.; **Charles E. Schauss**, Falls Church, Va.; **Vail P. Schermerhorn**, Portland, Oreg.; and **C. E. Vicroy**, Slidell, La.

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Fisheries Agreement Is Signed

New North Pacific fisheries agreements between the United States and the Soviet Union, signed recently in Washington, D.C., have established lower quotas and reduced the areas and time periods of Soviet fishing operations in international waters adjacent to the U.S.

The "Agreement Regarding Fisheries in the Northeastern Pacific Ocean off the Coast of the United States of America" which covers an area from California north to Alaska, including the Bering Sea, is effective through December 31, 1976.

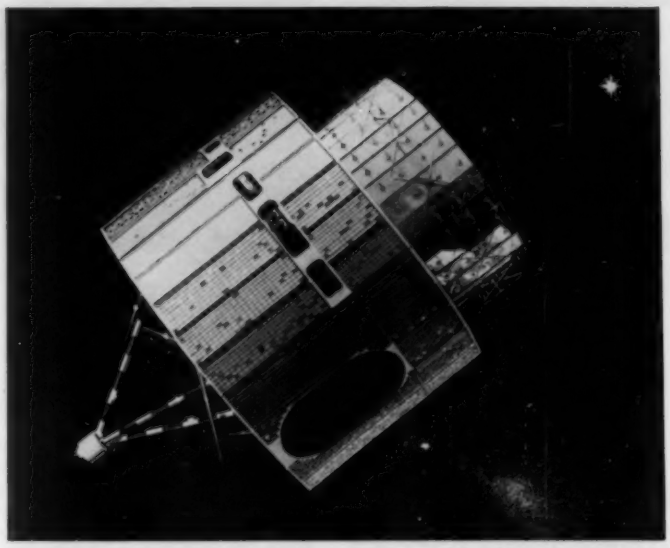
Robert W. Schoning, Director of the National Marine Fisheries Service and a member of the U.S. Delegation that negotiated the agreements, said he considered the agreements "real progress toward our goal of protecting stocks of special interest to U.S. fisheries. The Soviets have agreed to improve their methods of reporting catch statistics and have taken steps to control the taking of our Continental Shelf resources by their vessels."

The time during which use of Soviet mobile gear was prohibited during the U.S. king crab fishing season in six areas adjacent to Kodiak Island was extended. Closing these areas has proven to be valuable in reducing potential gear conflict between Soviet trawlers and U.S. crab pot fishermen, and has been instrumental in reducing the incidental catch of king and tanner crab as well as conserving groundfish, halibut, and shrimp stocks.

The Soviets agreed to refrain from trawling in certain areas in the eastern Bering Sea from December 1, to May 15 and not to bottom trawl in other areas during the same time period.

The agreements also imposed new controls on incidental catches of Continental Shelf fishery resources. The Soviets are prohibited from conducting specific fishing for Creatures of the Shelf—such as lobsters and crabs—except for those which can be taken under the king and tanner agreement. They are required to return any Creature of the Shelf to the sea immediately with a minimum of injury when they are taken incidentally to other fishing. Detailed records in their log books of these catches are also required. Soviet fishermen may not have any Creatures of the Shelf which were taken off the coast of another country on board their vessels when they are fishing over the U.S. Continental Shelf. Boarding and inspection of Soviet vessels by U.S. personnel to insure compliance with these agreements is now permitted.

GOES-A SATELLITE IS LAUNCHED



A 647-pound spacecraft, designed to monitor both the earth's environment and solar activity, was propelled 35,800 kilometers (22,250 miles) into space for NOAA.

It was launched on October 16, from Kennedy Space Center, Fla., atop a NASA Delta rocket.

The spacecraft was maneuvered into a fixed position above the earth, supplementing two other geostationary satellites operated by NOAA for environmental monitoring.

GOES-A (for Geostationary Operational Environmental Satellite-A), provides NOAA scientists with pictures of about one-quarter of the Earth at 30-minute intervals, day and night. Both visible light and infrared pictures are relayed during the day, and infrared at night.

Equipment aboard the satellite collects and relays non-visual environmental data, as well, from numerous remote sensing facilities on land and at sea.

From the mass of pictures and environmental information supplied by GOES-A, meteorologists, oceanographers and other scientists are provided with near-instantaneous information for such uses as weather detection and prediction, observing ocean currents, monitoring river water levels, and many others.

According to David S. Johnson, Director of the National Environmental Satellite Service, GOES-A and the two research development prototypes which preceded it represent a revolutionary step in environmental monitoring by satellite.

Pictures from GOES-A will be transmitted to ground stations for processing and further relay to regional weather stations operated by NOAA's National Weather Service.

GOES-A also will play a role in transmission of centrally prepared environmental maps and charts, as well as pictures from other satellites, from the NESS ground station to distant locations.

Some of the equipment aboard GOES-A is designed to enable it to receive data transmitted from up to 10,000 sensing stations, or platforms, such as ocean buoys, and river flow meters; and to relay this information to a data collection center at the World Weather Building, operated by NOAA just outside Washington. From there the material is distributed to those agencies and organizations which operate the platforms, and to others.

Habitat To Remain Under Ice

Emphasizing simplicity, an underwater habitat designed and constructed by mechanical engineering students at the University of Wisconsin main campus in Madison has been placed on the bottom of Lake Mendota. University Sea Grant Program officials believe it will be the first underwater facility to remain in place under winter ice.

The habitat is seven feet in diameter, 12 feet long and weighs 6,000 pounds. It is resting in 28 feet of water some 175 feet north of the lake's Picnic Point. The shallow depth precludes the need for a decompression facility. It is suspended by cables between a metal basket on the bottom and a raft floating on the surface. Mooring is by concrete blocks. Inside there are a main control panel, emergency life support equipment and seating for divers. There are three portholes. A generator and compressor on the raft supply the habitat with electricity and air. After ice forms the surface facility will be a portable structure on the ice. (In typical Upper Midwest winters the lakes form ice thick enough to drive automobiles onto the lake.) A communications system provides four way contact between the surface, the habitat and two divers.

The principal purpose of the habitat will be to train scientists to do their own underwater research instead of relying on divers to do it for them.

Funding for the project is shared jointly by Sea Grant and the state.

Privacy Act Protects Records On Individuals

Public Law 93-579, commonly called the Privacy Act of 1974, was effective September 27, 1975. The Act is intended to protect records and other information pertaining to individuals from unauthorized disclosure. It also gives individuals access to their own records and permits employees to request that these records be changed, if incorrect. Further, it provides a means for contesting any information in the record. There are, however, certain types of records that still may not be disclosed to the individual.

The implementation of the Act is complex, since it covers all records of individuals which can be retrieved by some identifying item, such as name or Social Security number.

The Act states, ". . . in order to protect the privacy of individuals identified in information systems maintained by Federal agencies, it is necessary and proper . . . to regulate the collection, maintenance, use, and dissemination of information by such agencies."

NOAA is working with the Department to determine its effect on employees and to determine precisely how it will be implemented.

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1975 NOAA and EEO Award Winners Announced

Dr. Machta

Cdr. Swanson

Mr. Ethridge

Mr. Norris

Mrs. Loman

Mrs. Schadt

Five NOAA employees have been selected to receive 1975 NOAA Awards, and two have been recognized for their outstanding contributions to NOAA's Equal Employment Opportunity activities. They were honored along with recipients of NOAA Unit Citations awarded since the 1974 NOAA Award ceremony.

Receiving $1,000 NOAA Awards are:

Dr. Lester Machta, Director of the Environmental Research Laboratories' Air Resources Laboratory in Silver Spring, Md., for Scientific Research and Achievement;

Cdr. R. Lawrence Swanson, Project Manager for ERL's Marine Ecosystems Analysis (MESA) program New York Bight Project, Stony Brook, N.Y., for Program Administration and Management;

Dr. Harry R. Glahn, Deputy Director of the National Weather Service's Techniques Development Laboratory in Silver Spring, for Engineering and Applications Development;

Ernest S. Ethridge, Official in Charge of the NWS Office at Shreveport, La., for Public Service; and

Russell T. Norris, recently retired as Director of the National Marine Fisheries Service's Northeast Region, Gloucester, Mass., for Public Service.

Recipients of the $500 EEO Awards for 1975 are:

Lena C. Loman, Chief of the Programming Support Section of the Automation Division at the NWS National Meteorological Center, Camp Springs, Md.; and

June D. Schadt, Administrative Clerk for the Sandy Hook Laboratory of the NMFS Middle Atlantic Coastal Fisheries Center, Highlands, N.J.

Dr. Machta was selected for his award for discovering and solving a wide variety of environmental problems related to global circulation, climate, and pollution. He conceived and led a project to determine the world's oxygen supply which conclusively demonstrated no decrease in global oxygen content over the past 60 years. He has worked with scientists of other Federal agencies and other nations on CO_2 monitoring programs, and has made what is probably the best prediction of what carbon dioxide levels in the atmosphere will be in the future.

Cdr. Swanson was recognized for his "exceptional leadership and ingenuity in the formation and execution of the MESA New York Bight Project," which he had headed since its beginning.

Through studies of the physical, chemical, and biological characteristics of the New York Bight (the ocean area south of Long Island, N.Y. and east of New Jersey where dredge spoils, industrial wastes, sewage sludge, and toxic acids produced by millions of people and numerous industries are dumped), NOAA scientists and others involved in the project are determining the effects of this waste dumping on the area's fisheries and beaches.

Dr. Glahn's contributions include development of a method for combining computer-model statistics with surface observations of weather to arrive at highly refined forecasts of the probability of precipitation, its type and amount, maximum and minimum temperatures, surface windspeed and direction, cloud amount, ceiling and visibility, and the probability of thunderstorms. Known to forecasters as Model Output Statistics (MOS), this method is one of the major advances in meteorology in the past decade.

Mr. Ethridge was honored "for outstanding work and competence in informing and warning the public of storm events," such as his timely and well written warnings of tornadoes, severe thunderstorms and flash floods for the parts of four states under WSO Shreveport's responsibility.

Mr. Norris was employed by NMFS and its predecessor agency for 17 of his more than 30 years of Federal service, and continuously demonstrated outstanding leadership and personal commitment to the Nation's natural resources.

Mrs. Loman chaired EEO committees of both the NWS and NOAA in 1974. During this period, major EEO activities were initiated, including the Scientific Upward Mobility training program, EEO Awareness Day ceremonies, and special commemoration by NOAA of Martin Luther King's birthday. When EEO activities conflicted with her professional work in a staff of 27 mathematician-programmers, Mrs. Loman devoted her own time to EEO affairs. Her dedication to the task, said the nomination statement, "has inspired supervisors to make every effort to place minority and women candidates in important jobs in her division."

Mrs. Schadt was cited for dedicated and superior service in fostering the equal opportunity objectives of the Department of Commerce, NOAA, NMFS, and the Center.

The following groups of employees, whose individual and collective efforts have made substantive contributions to the programs or objects for which NOAA was established, are the Unit Citation winners recognized.

In the Environmental Data Service:

Data Digitizing Section, Data Translation Branch, ADP Services Division, National Climatic Center, Asheville, N.C.;

In the Environmental Research Laboratories:

Boundary Layer Dynamics Group, Weather Modification Program Office, Boulder, Colo.;

Doppler Radar Group, Wave Propagation Laboratory, Boulder; and

Nucleation Chemistry Program Staff, Atmospheric Physics and Chemistry Laboratory, Boulder.

In the National Environmental Satellite Service:

Operational Satellite Snow Mapping Program, Analysis Branch, Data Processing and Analysis Division, Office of Operations, In Suitland, Md.; and

Polar Scanner Product Development Section, Sensor Processing and Analysis Division, Office of Operations, in Suitland.

In the National Marine Fisheries Service:

Middle Atlantic Coastal Fisheries Center, Highlands, N.J.;

Northwest Fisheries Center, Seattle, Wash.; and

Pollution Abatement Research Team, Pacific Utilization Research Center, Seattle.

In the National Ocean Survey:

Horizontal Branch, National Geodetic Survey Information Center, Rockville, Md.;

Information and Distribution Branch, NGS Information Center, Rockville, Md.;

NGS Chart Sales and Control Data Office, Anchorage, Alaska;

Nautical Engraving Section, Negative Engraving Branch, Reproduction Division, Office of Aeronautical Charting and Cartography, Washington, D.C.;

NOAA Ship David Starr Jordan;

NOAA Ship Fairweather;

NOAA Ship McArthur;

NOAA Ship Mt Mitchell;

In the National Weather Service:

Aerospace Observations Unit, NWS Support Facility, Wallops Flight Center, Wallops Island, Va.;

Digitized Radar Experiments (D/RADEX) Project Office, Integrated Systems Laboratory, Systems Development Office, Silver Spring, Md.;

Environmental Meteorological Support Unit, Weather Service Forecast Office in Pittsburgh, Pa.;

Islas Del Cisne (Swan Island), Honduras, Meteorological Station, Overseas Operations Division;

River Forecast Center in Atlanta, Ga.;

Upper Air Unit, Fort Totten, N.Y.;

Voluntary Assistance Program Field Representatives, Overseas Operations Division;

Weather Service Forecast Office in Atlanta, Ga.;

Weather Service Meteorological Observatory in Monett, Mo.;

Weather Service Office in Erie, Pa.;

Weather Service Office in Norfolk, Va.; and

Weather Service Office in Springfield, Mo.;

In the Office of Administration:

Incentive Awards Program Office, Operations Branch, Personnel Department, Rockville, Md.

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NMFS Reports On Trace Elements In Fish

The vast majority of 106 species of edible fish and shellfish tested for mercury content in a recent National Marine Fisheries Service resource survey are well within interim guidelines established by the Federal Drug Administration.

More than 94 percent of the 2400 samples of the 106 species examined by the NMFS Southeast Utilization Research Center in College Park, Md., were below the FDA's guidelines of 0.5 parts per million of mercury.

The approximately six percent of the samples found to contain more than 0.5 ppm were from fish not ordinarily sold in the United States for consumption—marlin, sharks, grouper, and little tunny.

The scientists gathering samples for analysis did not collect any swordfish, which some years ago all but disappeared from American tables because of reported high mercury content and the concern that too much mercury intake can cause cancer.

The resource survey is the second stage of a planned three-step investigation by the Commerce Department into the occurrence and significance of a number of trace elements in fish available to consumers.

The first stage, a product survey, was carried out earlier on 29 species of widely consumed fish for five trace elements. More than 96 percent of the 334 samples examined in this study were within FDA guidelines.

As part of the total investigation, when results from either the product or resource surveys indicate a species has elevated levels of an element, additional samples will be analyzed to obtain information necessary to define the extent of the problem and to develop a working plan to manage it.

Barbara Gainey Named NOAA's EEO Officer

Ms. Barbara Gainey has been appointed as the NOAA EEO Officer, succeeding Simon Morgan, who has returned to the NOAA Personnel Division.

Ms. Gainey was previously the EEO Officer for the U.S. Customs Service, U.S. Department of the Treasury. While serving in that position she also served as Deputy Director of the Equal Opportunity Division at Customs. She was responsible for the coordination and implementation of the nationwide system of affirmative and complaint processing.

Ms. Gainey also served as Federal Woman's Program Coordinator for Customs. She directed the program for writing policy and sponsored Federal Women's Program and International Women's Year activities and functions.

Her goal in NOAA is to see an "improvement in the overall EEO posture in NOAA and greater awareness of the complaint process."

She is a native of Washington, D.C., and attended George Washington University.

Computer On-Line Data Bases Available From OASIS System

The Oceanic Index and Meteorological and Geoastrophysical Abstracts data bases are now available to users for on-line interactive searching as part of the Environmental Data Service's Oceanic and Atmospheric Scientific Information System (OASIS). The data bases can be accessed through any teletype-compatible terminal over direct-dial, low cost telephone lines.

Oceanic Index is an automated, on-line version of the bi-monthly publication, *Oceanic Abstracts*. Coverage is from 1964 to the present and consists of approximately 76,500 citations. The data base contains citations to published literature relating to the oceans and freshwater-saltwater interface in the subject areas of acoustics, biology, fisheries, geology, meteorology, oceanography, optics, and pollution.

Meteorological and Geoastrophysical Abstracts is the automated, on-line version of the monthly journal of the same name. Present coverage of the on-line data base is for 1972-74. The years of 1975 and 1970-71 will be added during the next few months. The data base includes articles on astrophysics, hydrology, meteorology, and physical oceanography.

EFFECTS OF DOUBLING CO_2 IN ATMOSPHERE STUDIES

Human activity is steadily adding carbon dioxide to the atmosphere, theoretically causing a gradual warming of the earth. But scientists with the Environmental Research Laboratories have found that the effects of an increase in carbon dioxide would be much more complex than worldwide warming. The amount of warming would vary geographically, humidity would increase, evaporation and precipitation rates would intensify, and there would even be some cooling in the stratosphere.

Dr. Syukuro Manabe and Richard T. Wetherald of ERL's Geophysical Fluid Dynamics Laboratory in Princeton, N.J., have used a general circulation model of the atmosphere to predict some of the effects of doubling the concentration of carbon dioxide.

It has been estimated that combustion of fossil fuels at projected rates may increase the amounts of carbon dioxide in the atmosphere by as much as 20 percent during the latter half of this century. Carbon dioxide acts as a sort of atmospheric gate-keeper, admitting solar radiation and trapping upward radiation from the earth.

The NOAA researchers found that the doubling of carbon dioxide produces a warming in the lowest layer of the atmosphere of as much as 10 degrees Celsius (18 degrees Fahrenheit) in polar regions.

In the stratosphere—the atmospheric layer above the troposphere—an increase of carbon dioxide would have the opposite effect, a decrease in temperature of as much as 6 degrees Celsius (10.8 degrees Fahrenheit).

ROBOT FOR OCEAN RESEARCH PASSES UNDERWATER TESTS

A project supported by the Sea Grant Program and Massachusetts Institute of Technology has successfully operated an underwater robot using an onboard mini-computer to guide the vehicle and to store data collected by the sensing instruments.

The accomplishment is the most recent development in a student research project that began in 1973.

The torpedo-shaped robot submarine—designed for oceanographic research—was operated under computer control for the first time at the MIT Department of Ocean Engineering's Summer Laboratory Program in Castine, Me. Then, at a lake near Boston, the vehicle demonstrated several maneuvers that included circles, figures-of-eight and out-and-back preset compass runs.

The robot—eight feet long, 15 inches in diameter, weighing 250 pounds—has been designed, built and tested by undergraduate and graduate students.

The underwater robot, which has an aluminum body and fiberglass nose and tail, is battery driven and designed to travel 20 miles at three knots at a maximum depth of 200 feet.

Professor A. Douglas Carmichael (left) and some of the students who have worked on the robot submarine project at the Massachusetts Institute of Technology (from left) are: Charles H. Mazel, Stuart D. Jessup, William Burke, Glenn J. Keller, and Deborah S. Hoover.

noaa/people

J.R. Gulick, Meteorologist in Charge of the Kennedy Space Center Section of the National Weather Service Spaceflight Meteorology Group was awarded NASA's Exceptional Service Medal for his role in the Apollo-Soyuz Test Project.

Dr. Helmut K. Weickman, Director of the Environmental Research Laboratories' Atmospheric Physics and Chemistry Laboratory in Boulder, Colo., has been awarded a degree of honorary doctor by the University of Clermont in France.

Wesley M. Butler, David J. Friis, Frederick K. Ganjon, and **Dr. Wayne E. McGovern** are among the 17 scientists, engineers, and technologists selected to participate in the Commerce Department's 1975-1976 Science and Technology Fellowship program.

Donald R. Whitman has been selected as the new Chief, Data Acquisition in the National Weather Service's Central Region Headquarters Division in Kansas City, Mo.

James R. Wiggins of the Moline, Illinois, National Weather Service Office has been awarded the Department of Commerce Bronze Medal.

Lt. Thomas W. Ruszala has been named Junior Officer of the Year by the Association of Commissioned Officers of the NOAA Corps.

David P. Barnes, Jr. has been named Meteorologist in Charge at WSFO New Orleans, La.

Dr. Harry P. Foltz has been named Director of the Southern Region of the National Weather Service.

Walter J. Gully received a Department of Commerce Bronze Medal.

Dr. Rudolf J. Engelmann has been appointed Director of the Environmental Research Laboratories' Outer Continental Shelf Environmental Assessment Program.

Cdr. Donald R. Tibbit is now Director of the National Ocean Survey's Lake Survey Center in Detroit, Mich.

Howard W. Pollock, NOAA's Deputy Administrator, has been chosen Distinguished Alumnus of 1975 by the University of Houston.

Julius Badner has been appointed Chief of the Executive Affairs Staff of National Weather Service headquarters in Silver Spring, Md.

Amor Lane has been designated Acting Director of the Office of Marine Minerals.

Michael Wascom of NOAA's Office of Congressional Liaison has recently been assigned to the Office of Sea Grant. He will supply the Congressional staffs with information on various Sea Grant research projects and publications in order to assist the Federal lawmakers in writing legislation dealing with marine-related activities.

Sen. Lowell Weicker of Connecticut (left): and Cong. Bill Alexander of Arkansas (right), receive NOAA Aquanaut patches from Deputy Administrator Howard W. Pollock at a luncheon of the American Oceanic Organization in Washington, D.C. The three discussed undersea expedition in Hydro-Lab.

A NOAA UNIT CITATION was presented recently to the crew of the NOAA Ship David Starr Jordan for outstanding work for the Southwest Fisheries Center, La Jolla, Calif. The Award was presented by R. Adm. H. R. Lippold, Jr., Director of the National Ocean Survey's Pacific Marine Center. Present at the ceremony were (standing from left) Thomas Calluerg, Donald Smith, Robert Bearce, Thomas Cameron, Manuel Ferreira, Samuel Heaton, Vessel Master Charles Forster, Admiral Lippold, Lloyd Farrar, Milton Roll, Floyd Tow, Harold Paul, (seated) Wayne Ellis and Julius Cairns.

Freel M. Hubbard recently received a Department of Commerce Bronze Medal.

Dr. Edwin Kessler, Director of the Environmental Research Laboratories' National Severe Storms Laboratory in Norman, Okla., has been appointed Visiting Professor at Massachusetts Institute of Technology's Department of Meteorology for the fall semester.

Dr. Donald J. P. Swift, of the Marine Geology and Geophysics Laboratory, has been appointed to the editorial board of Marine Geology.

Mary J. Breeskin was awarded a Special Achievement Award.

Oliver J. Wattenbarger received a Department of Commerce Bronze Medal.

Cdr. Wesley V. Hull has been appointed Commanding Officer of the NOAA Ship Mt Mitchell.

Joseph Pileggi has been named Chief of the NMFS Division of Statistics and Market News.

Philip E. Shideler has been appointed Meteorologist-in-Charge of the National Weather Service Forecast Office at Topeka, Kans.

Edward C. Snead, Jr., has been named Chief of the Facilities Branch in the Technical Services Division of the National Ocean Survey's National Oceanographic Instrumentation Center in Washington, D.C.

Harvey A. Teyler is the new Official-in-Charge at the National Weather Service Office at Alamosa, Colo., replacing John C. Stokes, who has retired.

Robert L. Stalnaker, Jr., is the new Meteorologist in Charge at the National Weather Service Meteorological Observatory in Stephenville, Tex.

Dr. Rex J. Fleming has joined the NOAA Staff as Director of the U.S. First GARP Global Experiment (FGGE) Project Office.

Dr. Elbert H. Ahlstrom, Senior Scientist at the National Marine Fisheries Service Southwest Fisheries Center's laboratory in La Jolla, Calif., was nominated by the Fellows of the San Diego Society of Natural History and has been selected Scientist-of-the-Year by the Natural History Museum Board of Trustees.

Billy J. Crouch has been selected to head the Lubbock, Tex., Weather Forecast Office.

Robert L. Storey, has been named Official in Charge of the Stockton, Calif., Weather Service Office.

Robert E. Woodward, Jr., has been appointed Official in Charge of the National Weather Service Office in Roswell, N. Mex.

Michael Crane, John Audet, Peter Topoly, and **Gary Falk** have joined the Environmental Data Services' National Oceanographic Data Center to participate in the Outer Continental Shelf Energy Program of the Marine Ecosystem Analysis Project.

William J. McKee has been selected for the position of Executive Officer at the National Weather Service Office Eastern Region Headquarters in Garden City, N.Y.

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NWS Supports Missions To Planets

The National Weather Service Space Operations Support Division has entered into a reimbursable agreement with the National Aeronautics and Space Administration's Jet Propulsion Laboratory in Pasadena, Calif. to provide weather support for missions to distant planets, notably to the Mariner-Jupiter-Saturn 1977 mission. It is expected that the project will continue for several years and will involve something more than a half-man-year effort annually.

The reason for the need for meteorological guidance is that the optional X-Band mode of communication, which can handle about four times more data in a given period than can the other available channels, is vulnerable to weather influences in the line of sight to the tracking stations.

According to Kenneth M. Nagler, Chief of the Space Operations Support Division, initially, the SMG staff will be working on the X-Band degradation climatology and forecastability. It will also help the Jet Propulsion Laboratory staff develop a model for assessing the best mode of data transmission depending on the prediction of pertinent weather factors.

PUGET SOUND ENERGY RESEARCH BEGINS

Environmental Research Laboratories scientists are beginning an intensive study of northern Puget Sound to determine the probable ecological impact of increasing oil shipment and refining activities there.

Funded by the Environmental Protection Agency as part of a larger, national energy program, the study is closely coordinated with ERL's Marine Ecosystems Analysis (MESA) program study in southern Puget Sound to identify and measure the impact of man on the marine environment and its resources.

Impetus behind the present energy study in northern Puget Sound is the accelerating oil traffic through the Strait of Juan de Fuca and the interisland channels, reflecting the Sound's growing role in oil transshipment and refining, and its prospective importance as a terminus for Alaskan oil.

Some estimates have the area's refinery capacity doubling by 1990, and tanker traffic increasing tenfold by 2000. At the same time, there has been little experience with oil spills in a cold-water environment like Puget Sound's.

"Our primary concern," Dr. Howard S. Harris, who manages the new energy-related study, explained, "is with oil spilled on the water's surface. Later we will characterize the effects of chronic oil seepage into the Sound,

To do this, the researchers will run environmental assessment surveys, gather baseline information on petroleum hydrocarbons now present in the environment, and attempt to determine what happens to such pollutants in this particular ecosystem.

The northern Puget Sound energy study will use talent and facilities from many of the NOAA facilities in the Seattle area. Much of the physical oceanographic work will be done by ERL's Pacific Marine Environmental Laboratory. Petroleum hydrocarbon analyses will be made by the National Marine Fisheries Service Northwest Fisheries Center in Seattle, in a continuing study of the impact of pollutants on marine plants and animals. Ships for the project will come from the Pacific Marine Center of the National Ocean Survey, which is also providing valuable tide, current, and hydrographic survey data for northern Puget Sound.

GEODETIC SURVEY DATA AVAILABILITY SPEEDED

A speed-up in the processing of land measurement data for use by engineers and surveyors has been announced by the National Geodetic Survey.

Measurements can now be transmitted from the field to a central computer at NGS headquarters in Rockville, Md., through terminals connected to telephones.

The new system is being tested in the field and it is expected that in the near future the results of field work will be available for use by local surveyors and engineers within several weeks of a project's completion. In the past, this has normally taken many months since hand computations were necessary before the data could be checked, verified and approved for use in states and local communities.

Under the new method, upon completion of field work, all data will be stored in the central computer at Survey headquarters and will be available immediately to office personnel there for insertion into the national networks of distances and elevations maintained by NGS.

White Shrimp Mark-Recapture Study Is Underway In Galveston Bay Area

Biologists of the National Marine Fisheries Service Gulf Coastal Fisheries Center in Galveston, Tex., are directing and participating in a mark-recapture study of white shrimp in the Galveston Bay area in cooperation with the Texas Parks and Wildlife Department and with the Galveston County Extension Marine Agent Program (supported by Sea Grant at Texas A and M University).

The purpose of the study is to obtain estimates of rates of growth, migration, fishing mortality and natural mortality in white shrimp (Penaeus sertiferus) in the area.

More than 19,000 white shrimp were marked with Petersen disk tags and released in Moses Lake, an approximately 1,500-acre estuarine lake near Texas City, Tex., and 556 of the marked shrimp have been recaptured.

The biologists also will obtain information on which shrimp catch and fishing effort in Moses Lake by interviewing fishermen and bait shrimp dealers.

This work in part of the shrimp population dynamics research activities of the NMFS GCFC Task entitled "Fishery Analysis: Shrimp, Northern Gulf of Mexico."

White Shrimp (Penaeus sertiferus) marked with a Petersen disk tag. Tag is attached to second abdominal segment.

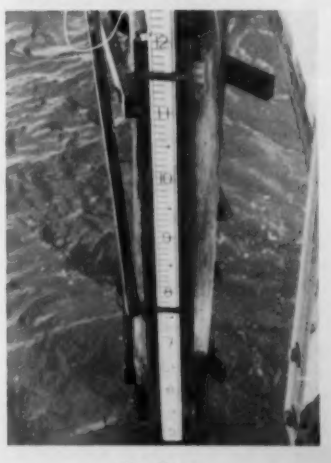
Ocean Survey Completes Florida Key Tidal Study

The completion of the first jointly sponsored tide study of the Florida Keys was announced by the National Ocean Survey and Florida's Department of Natural Resources.

Rear Admiral Allen L. Powell, Director of NOAA's National Ocean Survey said that the completion of the comprehensive tidal work in "this complicated area represents a real milestone in the Florida Boundary Survey." Accurate coastal boundary lines can now be located for determination of State, Federal, and private ownership of upland and submerged lands throughout the area.

The 15-month survey, carried out as part of a continuing cooperative program between Florida and the National Ocean Survey, established more than 180 tide stations throughout the Florida Keys. Cal Thurlow, Chief of Tides Branch said, "This represents approximately 5000 days of individual tide data collection and the establishment of almost 1000 tidal bench marks for which elevations of mean high water and mean low water are published." After NOS completes its tidal analysis, surveyors can quickly and precisely locate coastal boundary lines.

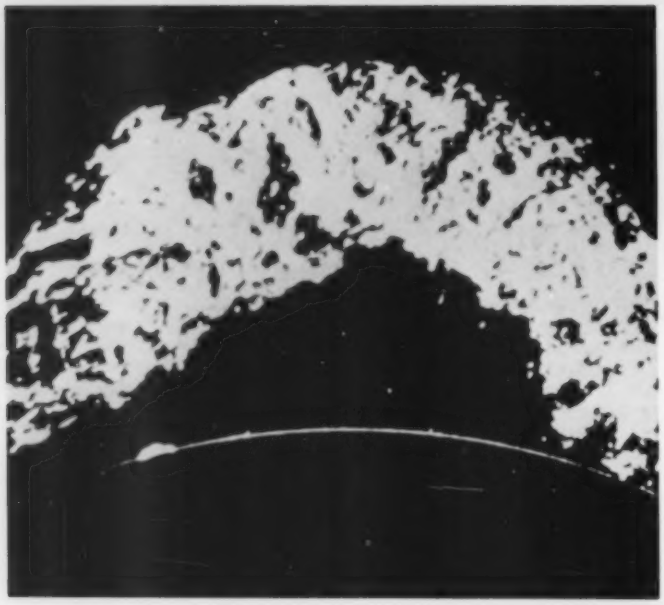
The general law states that land above the mean high water lines is privately owned. Submerged lands beyond three miles offshore on the Atlantic Ocean side and three leagues on the Gulf of Mexico side, measured from the mean low water line, have Federal jurisdiction. The submerged land in between the mean high water line and the offshore Federal boundary is State sovereignty land. Any future disputes over submerged oil and mineral rights, sunken treasures, fishing rights, private property development make the precise location of these lines extremely important.



Tide Gage

noaa/update

Solar Flares Herald New 11-Year Cycle of Activity



Late last August an active area on the sun produced a series of moderate to major flares that reverberated in the earth's magnetic field, disturbed the ionosphere (the electrically charged layer of the upper atmosphere), and dusted our corner of space very lightly with energetic solar protons.

For Environmental Research Laboratories' scientists, the active region and its flares meant more than a temporary increase in solar activity—they also marked the coming of a kind of springtime on the sun, when one 11-year cycle nears its end and another one begins. The August flares were the first significant activity of the new cycle, number 21. Now, solar activity will gradually increase to a maximum in 1979 or 1980, then diminish toward the next solar minimum about 1986.

"The recent activity occurred in conjunction with a sunspot group at about 28 degrees north solar latitude," reports Gary R. Heckman, Acting Chief of the Space Environmental Laboratory's Space Environment Services Center in Boulder, Colo.

This sunspot group also had the magnetic configuration of a new cycle."

In the solar cycle, Heckman says, sunspots first tend to form at solar latitudes between about 20 and 30 degrees; then, as the cycle continues, they occur closer and closer to the solar equator, coming within about five degrees of the equator by the solar minimum.

The advent of a new cycle cued ERL scientists to begin looking for the end of the old cycle, and for the "impossible" solar magnetic field which researchers think—but can scarcely believe—comes at the solar minimum.

Laser Beam Technique "Fingerprints", Traces Spilled Pollutants In Water

A way to "fingerprint" spilled pollutants with a laser beam and trace them to the sources has been developed by chemists at the University of Rhode Island.

The laser technique has already proven effective in fingerprinting some 25 contaminants, the Sea Grant chemists have found. They hope to perfect the technique and provide the first method capable of identifying most of the hundreds of waterborne substances classified as hazardous by the Environmental Protection Agency and the U.S. Coast Guard.

As part of the same study, the URI team has monitored Narragansett Bay and the Sakonnet River and found a variety of toxic chemicals including chlorinated hydrocarbons, petroleum hydrocarbons and tar flakes.

The team consists of Dr. Christopher Brown, associate professor of chemistry and director of the project, and assistants, Ms. Patricia F. Lynch, Mark Ahmadjian and Carl Baer.

Fourth Annual Report of NACOA Is Released

Establishment of a 200-mile U.S. Economic Resource Zone for the ocean waters off our coasts is recommended by the National Advisory Committee on Oceans and Atmosphere (NACOA) in its recently released Fourth Annual Report as a first step in protecting coastal fisheries against overfishing.

"We cannot afford to wait but must take action now, even if interim," the Committee said. Urgent action is required to bring the living resources of the ocean, and other vulnerable aspects of the marine environment, under "positive rational management," NACOA wrote.

In previous reports NACOA had counseled patience in awaiting the outcome of the Law of the Sea Conference held first in Caracas, Venezuela, in 1974, then in Geneva, Switzerland, in 1975. The Conference, the Committee said, has not yet been able to reach agreement even after protracted preparation and negotiation.

The report treats various features involved in the balanced management of offshore development and environmental protection, and notes with concern the slakening support for basic research in the oceans and atmosphere which is needed to understand the environment, its properties, and its resources.

NACOA urges that, as the U.S. gets ready for the management of an Economics Resources Zone, it take explicit account of our own interests but with due regard for our international obligations. The issues with foreign policy impact include fisheries management, freedom of science, and by analogy—although in general outside the Economic Resources Zone—the mining of minerals from the bottom of the deep sea.

NACOA urges that we get on with oil and gas development on the outer continental shelf, and the siting of power plants and of deep water ports in a framework that assures environmental protection and a voice for both State and local officials.

To clear the way for energy resource exploitation offshore, NACOA recommends amending current coastal zone legislation to compensate states adversely affected by offshore development of oil and gas, that private industry continue its role in oil and gas exploration and development, and that environmental impact assessments required for approval of energy resource exploitation be developed in two stages reflecting the different degree of hazard involved in exploration as compared with development. The Committee also recommends expansion of the informational services of NOAA's Office of Coastal Zone Management to serve the rapidly growing states' needs of coastal zone managers.

NMFS Acts To Protect Porpoises

Procedures designed to lead to a substantial reduction in incidental porpoise deaths during U.S. yellowfin tuna purse seine fishing in the eastern tropical Pacific in 1976 have been announced by Robert W. Schoning, Director of the National Marine Fisheries Service.

"Under no circumstances will a level of mortality be permitted that jeopardizes maintenance of porpoise stocks," he said.

The fleet's performance will be monitored by NMFS observers aboard a scientifically determined sample of U.S. vessels during the fishing season.

These observers will provide the information about the extent of porpoise mortality and its causes. Their data will be used, in addition, by NMFS and tuna industry scientists and gear experts as a basis for improving gear and fishing procedures to reduce porpoise mortality further.

To achieve a mortality level significantly below that of 1975, a quota for 1976 will be established next May if the total number of porpoise deaths for the year is projected to exceed 70 percent of the total 1975 toll. The present estimate of the 1975 kill, although uncertain, is expected to approximate 130,000 animals. A final estimate will be available early in 1976.

Action to impose a quota will be taken primarily on the basis of observer data on numbers of porpoises killed per set. The regulations which will be promulgated are aimed specifically at reducing the number of porpoises killed in each setting of the purse seine. In addition, total mortality, which is related to the total tuna catch and other characteristics of the fishing season, will be considered. This procedure for setting a quota and estimates of porpoise mortality reductions that can be achieved assume that the 1976 fishing season will be similar to that of 1975. Any material differences in the two seasons will be given due consideration in the final establishment of the quota.

The NMFS Director will announce his decision regarding possible imposition of a 1976 quota during a public hearing to be held in Washington, D.C., in May.

noaa/people

NOS Issues First Metric Nautical Chart

The National Ocean Survey has issued its first metric nautical chart—and the first of five international charts it is to produce as part of a multination program sponsored by the International Hydrographic Organization.

International Chart INT. 501 (National Ocean Survey 501) covers a vast area of the Pacific Ocean off the west coast of the United States and Canada. It was compiled in accordance with IHO specifications and shows elevations and depth in metric units. Loran-A lines of position for electronic navigation are shown in addition to the usual nautical chart information. The scale of the chart is 1:3,500,000.

The IHO program is designed to provide a standard series of charts for the entire world which can be used by all nations. Each member nation is authorized to reprint charts in its own language, but employing the same form of navigational information, such as depth curves, sounding spacing, aids to navigation, and nautical symbols. Nations which have agreed to produce and issue international charts are Canada, West Germany, United Kingdom, France, Brazil, Argentina, Chile, Italy, Netherlands, Japan, India, New Zealand, Australia, and possibly South Africa.

SEA GRANT AIDS SALMON PROJECTS

California's troubled salmon resources continue to receive considerable attention from the UC Sea Grant program. Last year the Marine Advisory Program was initiating a saltwater rearing program in San Francisco Bay in cooperation with the National Marine Fisheries Service, the San Francisco Tyee Club and the California Department of Fish and Game. Ten thousand silver salmon were raised experimentally to a size of ½ pound and released into the Bay to see if saltwater rearing is a feasible method for enhancing local fishery resources. This project will expand this year to 40,000 silver (coho) salmon to be raised at Tiburon.

At the mouth of Tomales Bay, commercial fishermen, sports fishermen and county governments (Marin and Sonoma) will try a similar experiment with 10,000 silver salmon in an attempt to enhance the salmon fishery in the Tomales and Bodega Bay area. By holding the silver salmon to a large size (é oz. or more) they should stay close to their pen sites rather than migrating up and down the entire Pacific Coast.

Sea Grant Conference on Sharks

Resorts that fail to warn bathers of the danger of shark attack may leave themselves open to lawsuits, a Florida official warned at the recent "Sharks and Man: A Perspective" conference in Orlando, Fla., coordinated by the Florida Sea Grant Program's Marine Advisory Service.

"The duty to warn arises only where there is a special relationship between the warner and the warnee," suggested Thomas Harris, assistant attorney general of Florida. Such a relationship, he indicated, could include that between a seaside resort community and any potential bathers on its beach. It might also, he continued, include the relationship between fishermen—whose activities might attract sharks—and bathers on nearby beaches. Other topics discussed at the conference were Sharks and Man, Shark Population Dynamics, Shark Behavior Patterns, Anti-Shark Measures, and Commercial Utilization of Sharks.

Primary purpose of the conference was to put the shark hazard problem into perspective. The conference sessions featured some two dozen scientists, tourism officials, commercial and recreational fisheries specialists, publishers of recreational magazines and advertising personnel. Nearly thirty writers and broadcasters representing all media registered at the press room.

The conference was sponsored by the Florida Department of Natural Resources, National Marine Fisheries Service, Mote Marine Laboratory, Sarasota, Fla., the Coastal Plains Center for Marine Development Services, Wilmington, N.C., the Office of Naval Research, and the Florida Sea Grant Program.

Proceedings of the Conference will be published by the Florida Sea Grant Program and distributed to all registrants.

Fluorocarbons Detected In Stratosphere

Preliminary results of tests conducted by Environmental Research Laboratories scientists indicate that fluorocarbons of the types used in aerosol sprays and refrigeration systems reach the stratosphere essentially intact. The results also suggest that, once in the stratosphere, these compounds are broken down into components which may react with ozone there.

Both fluorocarbon-11 and fluorocarbon-12 were present in stratospheric samples gathered by NOAA balloons launched at Laramie, Wyo.

The samples also showed fewer fluorocarbons in the stratosphere at the higher altitudes probed, suggesting that they were being broken down by solar radiation in a process called "photodissociation."

"In our opinion, these results demonstrate directly that fluorocarbons are transported into the stratosphere with no large loss in the lower atmosphere," Dr. Arthur L. Schmeltekopf, leader of the stratospheric sampling program in ERL's Aeronomy Laboratory, said.

The preliminary findings, if supported by further sampling tests planned by NOAA and other organizations, would mean that fluorocarbons are transported into the stratosphere virtually intact. Then, solar radiation breaks them down into compounds which could react destructively with stratospheric ozone, the thin layer that shields the planet's surface from biologically damaging solar ultraviolet radiation, according to Dr. Schmeltekopf.

PROTOTYPE MAPS OF COASTAL ZONE ARE COMPLETED

The State of Florida, the U.S. Geological Survey (USGS), and NOAA have announced the completion of prototype coastal zone maps of the Ft. Pierce area.

The new coastal zone maps are the result of the first cooperative effort between State and Federal agencies to show the detailed land/water interface of the coastline.

The maps of the Ft. Pierce area show approximately equal land and water areas on a photograph base. All dimensions, elevations, and water depths have been shown in the metric system following the trend toward metrication in the U.S. It is anticipated that this cooperative mapping of the coastal zone will be the model for all coastal states.

Map features represent the completion of extensive field and aerial surveys of the coastal area.

Acoustic Sounders Used To Track Sewage Sludge

Using an underwater acoustic system originally designed for detecting schools of fish, NOAA scientists are studying the feasibility of tracking sewage sludge in the waters off New York and New Jersey.

The research is being concentrated within the New York Bight—a 15,000-square mile area extending from Cape May, N.J., to Montauk Point, N.Y., and seaward to the edge of the continental shelf approximately 100 miles offshore.

Ringed by densely populated communities, the New York Bight receives sewage sludge, the byproduct of waste water treatment, at a rate of about 150 million cubic feet a year in what is America's largest ocean dumping operation. But where this sludge finally ends up, and its environmental effect in the Bight, are unsolved problems. With the aid of ship-mounted acoustic sounders the NOAA oceanographers hope to find some of the answers.

The experiment is being carried out by the Environmental Research Laboratories' Atlantic Oceanographic and Meteorological Laboratories as part of ERL's Marine Ecosystems Analysis New York Bight Project.

"Locating suspended particles in the ocean by the acoustic sounding technique has potential application for monitoring many kinds of dredging or dumping operation in the coastal zone and for deep ocean mining activities," says Dr. John R. Proni, an oceanographer with AOML's Ocean Remote Sensing Laboratory in Miami.

Dr. Proni and his colleagues are operating two acoustic sounders aboard NOAA's 180-foot ship Kelez as it follows a sludge-filled New York City barge five miles or more southeast of Ambrose Light near the New Jersey coast.

Following the completion of dumping, the Kelez will crisscross the area, mapping what happens to the dumped material over several hours' time.

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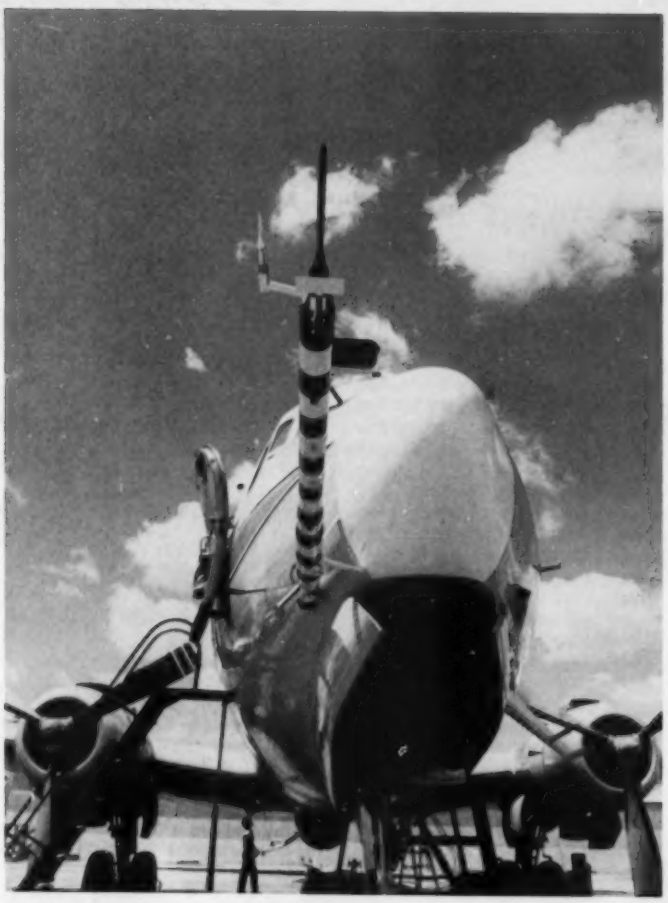

For story see page 49.

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